McConachie HM, Parr J, Glod M, Hanratty J, Livingstone N, Oono IP, Robalino S, Baird GB, Beresford T, Charman T, Garland D, Green J, Gringras P, Jones G, Law J, Le Couteur AS, Macdonald G,
McColl EM, Morris C, Rodgers J, Simonoff E, Terwee CB, Williams K.

Systematic review of tools to measure outcomes for young children with autism spectrum disorder.

Health Technology Assessment 2015, 19(41).

DOI link to publisher version:

http://dx.doi.org/10.3310/hta19410

HEALTH TECHNOLOGY ASSESSMENT

VOLUME 19 ISSUE 41 JUNE 2015
ISSN 1366-5278

Systematic review of tools to measure outcomes for young children with autism spectrum disorder

Helen McConachie, Jeremy R Parr, Magdalena Glod, Jennifer Hanratty, Nuala Livingstone, Inalegwu P Oono, Shannon Robalino, Gillian Baird, Bryony Beresford, Tony Charman, Deborah Garland, Jonathan Green, Paul Gringras, Glenys Jones, James Law, Ann S Le Couteur, Geraldine Macdonald, Elaine M McColl, Christopher Morris, Jacqueline Rodgers, Emily Simonoff, Caroline B Terwee and Katrina Williams

NHS
National Institute for Health Research

DOI 10.3310/hta19410

Systematic review of tools to measure outcomes for young children with autism spectrum disorder

Helen McConachie,[1*] Jeremy R Parr,[2] Magdalena Glod,[1] Jennifer Hanratty,[3] Nuala Livingstone,[3] Inalegwu P Oono,[1] Shannon Robalino,[1] Gillian Baird,[4] Bryony Beresford,[5] Tony Charman,[6] Deborah Garland,[7] Jonathan Green,[8] Paul Gringras,[4] Glenys Jones,[9] James Law,[1] Ann S Le Couteur,[1] Geraldine Macdonald,[3] Elaine M McColl,[1] Christopher Morris,[10] Jacqueline Rodgers,[2] Emily Simonoff,[6] Caroline B Terwee[11] and Katrina Williams[12]

[1]Institute of Health and Society, Newcastle University, Newcastle upon Tyne, UK
[2]Institute of Neuroscience, Newcastle University, Newcastle upon Tyne, UK
[3]School of Sociology, Social Policy and Social Work, Queen's University Belfast, Belfast, Northern Ireland, UK
[4]Guy's and St Thomas' NHS Foundation Trust, London, UK
[5]Social Policy Research Unit, University of York, York, UK
[6]Institute of Psychiatry, Psychology & Neuroscience, King's College London, London, UK
[7]National Autistic Society North East Autism Resource Centre, Newcastle upon Tyne, UK
[8]Institute of Brain, Behaviour and Mental Health, University of Manchester, Manchester, UK
[9]School of Education, University of Birmingham, Birmingham, UK
[10]PenCRU, Child Health Group, University of Exeter Medical School, University of Exeter, Exeter, UK
[11]Department of Epidemiology and Biostatistics, VU University Medical Center, Amsterdam, The Netherlands
[12]University of Melbourne, Royal Children's Hospital and Murdoch Childrens Research Institute, Melbourne, Australia

*Corresponding author

Declared competing interests of authors: Ann S Le Couteur is one of the authors of the Autism Diagnostic Interview but receives no royalties; Elaine M McColl is a member of the NIHR Journals Library Editorial Group.

Published June 2015
DOI: 10.3310/hta19410

This report should be referenced as follows:

McConachie H, Parr JR, Glod M, Hanratty J, Livingstone N, Oono IP, *et al*. Systematic review of tools to measure outcomes for young children with autism spectrum disorder. *Health Technol Assess* 2015;**19**(41).

Health Technology Assessment is indexed and abstracted in *Index Medicus*/MEDLINE, *Excerpta Medica*/EMBASE, *Science Citation Index Expanded* (SciSearch®) and *Current Contents*®/ Clinical Medicine.

Health Technology Assessment

HTA/HTA TAR

ISSN 1366-5278 (Print)

ISSN 2046-4924 (Online)

Impact factor: 5.116

Health Technology Assessment is indexed in MEDLINE, CINAHL, EMBASE, The Cochrane Library and the ISI Science Citation Index.

This journal is a member of and subscribes to the principles of the Committee on Publication Ethics (COPE) (www.publicationethics.org/).

Editorial contact: nihredit@southampton.ac.uk

The full HTA archive is freely available to view online at www.journalslibrary.nihr.ac.uk/hta. Print-on-demand copies can be purchased from the report pages of the NIHR Journals Library website: www.journalslibrary.nihr.ac.uk

Criteria for inclusion in the *Health Technology Assessment* journal

Reports are published in *Health Technology Assessment* (HTA) if (1) they have resulted from work for the HTA programme, and (2) they are of a sufficiently high scientific quality as assessed by the reviewers and editors.

Reviews in *Health Technology Assessment* are termed 'systematic' when the account of the search appraisal and synthesis methods (to minimise biases and random errors) would, in theory, permit the replication of the review by others.

HTA programme

The HTA programme, part of the National Institute for Health Research (NIHR), was set up in 1993. It produces high-quality research information on the effectiveness, costs and broader impact of health technologies for those who use, manage and provide care in the NHS. 'Health technologies' are broadly defined as all interventions used to promote health, prevent and treat disease, and improve rehabilitation and long-term care.

The journal is indexed in NHS Evidence via its abstracts included in MEDLINE and its Technology Assessment Reports inform National Institute for Health and Care Excellence (NICE) guidance. HTA research is also an important source of evidence for National Screening Committee (NSC) policy decisions.

For more information about the HTA programme please visit the website: http://www.nets.nihr.ac.uk/programmes/hta

This report

The research reported in this issue of the journal was funded by the HTA programme as project number 11/22/03. The contractual start date was in June 2012. The draft report began editorial review in April 2014 and was accepted for publication in July 2014. The authors have been wholly responsible for all data collection, analysis and interpretation, and for writing up their work. The HTA editors and publisher have tried to ensure the accuracy of the authors' report and would like to thank the reviewers for their constructive comments on the draft document. However, they do not accept liability for damages or losses arising from material published in this report.

This report presents independent research funded by the National Institute for Health Research (NIHR). The views and opinions expressed by authors in this publication are those of the authors and do not necessarily reflect those of the NHS, the NIHR, NETSCC, the HTA programme or the Department of Health. If there are verbatim quotations included in this publication the views and opinions expressed by the interviewees are those of the interviewees and do not necessarily reflect those of the authors, those of the NHS, the NIHR, NETSCC, the HTA programme or the Department of Health.

Published by the NIHR Journals Library (www.journalslibrary.nihr.ac.uk), produced by Prepress Projects Ltd, Perth, Scotland (www.prepress-projects.co.uk).

Abstract

Systematic review of tools to measure outcomes for young children with autism spectrum disorder

Helen McConachie,[1]* Jeremy R Parr,[2] Magdalena Glod,[1] Jennifer Hanratty,[3] Nuala Livingstone,[3] Inalegwu P Oono,[1] Shannon Robalino,[1] Gillian Baird,[4] Bryony Beresford,[5] Tony Charman,[6] Deborah Garland,[7] Jonathan Green,[8] Paul Gringras,[4] Glenys Jones,[9] James Law,[1] Ann S Le Couteur,[1] Geraldine Macdonald,[3] Elaine M McColl,[1] Christopher Morris,[10] Jacqueline Rodgers,[2] Emily Simonoff,[6] Caroline B Terwee[11] and Katrina Williams[12]

[1]Institute of Health and Society, Newcastle University, Newcastle upon Tyne, UK
[2]Institute of Neuroscience, Newcastle University, Newcastle upon Tyne, UK
[3]School of Sociology, Social Policy and Social Work, Queen's University Belfast, Belfast, Northern Ireland, UK
[4]Guy's and St Thomas' NHS Foundation Trust, London, UK
[5]Social Policy Research Unit, University of York, York, UK
[6]Institute of Psychiatry, Psychology & Neuroscience, King's College London, London, UK
[7]National Autistic Society North East Autism Resource Centre, Newcastle upon Tyne, UK
[8]Institute of Brain, Behaviour and Mental Health, University of Manchester, Manchester, UK
[9]School of Education, University of Birmingham, Birmingham, UK
[10]PenCRU, Child Health Group, University of Exeter Medical School, University of Exeter, Exeter, UK
[11]Department of Epidemiology and Biostatistics, VU University Medical Center, Amsterdam, The Netherlands
[12]University of Melbourne, Royal Children's Hospital and Murdoch Childrens Research Institute, Melbourne, Australia

*Corresponding author helen.mcconachie@ncl.ac.uk

Background: The needs of children with autism spectrum disorder (ASD) are complex and this is reflected in the number and diversity of outcomes assessed and measurement tools used to collect evidence about children's progress. Relevant outcomes include improvement in core ASD impairments, such as communication, social awareness, sensory sensitivities and repetitiveness; skills such as social functioning and play; participation outcomes such as social inclusion; and parent and family impact.

Objectives: To examine the measurement properties of tools used to measure progress and outcomes in children with ASD up to the age of 6 years. To identify outcome areas regarded as important by people with ASD and parents.

Methods: The MeASURe (Measurement in Autism Spectrum disorder Under Review) research collaboration included ASD experts and review methodologists. We undertook systematic review of tools used in ASD early intervention and observational studies from 1992 to 2013; systematic review, using the COSMIN checklist (Consensus-based Standards for the selection of health Measurement Instruments) of papers addressing the measurement properties of identified tools in children with ASD; and synthesis of evidence and gaps. The review design and process was informed throughout by consultation with stakeholders including parents, young people with ASD, clinicians and researchers.

Results: The conceptual framework developed for the review was drawn from the International Classification of Functioning, Disability and Health, including the domains 'Impairments', 'Activity Level Indicators', 'Participation', and 'Family Measures'. In review 1, 10,154 papers were sifted – 3091 by full text – and data extracted from 184; in total, 131 tools were identified, excluding observational coding, study-specific measures and those not in English. In review 2, 2665 papers were sifted and data concerning measurement properties of 57 (43%) tools were extracted from 128 papers. Evidence for the measurement properties of the reviewed tools was combined with information about their accessibility and presentation. Twelve tools were identified as having the strongest supporting evidence, the majority measuring autism characteristics and problem behaviour. The patchy evidence and limited scope of outcomes measured mean these tools do not constitute a 'recommended battery' for use. In particular, there is little evidence that the identified tools would be good at detecting change in intervention studies. The obvious gaps in available outcome measurement include well-being and participation outcomes for children, and family quality-of-life outcomes, domains particularly valued by our informants (young people with ASD and parents).

Conclusions: This is the first systematic review of the quality and appropriateness of tools designed to monitor progress and outcomes of young children with ASD. Although it was not possible to recommend fully robust tools at this stage, the review consolidates what is known about the field and will act as a benchmark for future developments. With input from parents and other stakeholders, recommendations are made about priority targets for research.

Future work: Priorities include development of a tool to measure child quality of life in ASD, and validation of a potential primary outcome tool for trials of early social communication intervention.

Study registration: This study is registered as PROSPERO CRD42012002223.

Funding: The National Institute for Health Research Health Technology Assessment programme.

Contents

List of tables

List of figures

List of abbreviations

ABC	Aberrant Behavior Checklist
ADI-R	Autism Diagnostic Interview-Revised
ADOS	Autism Diagnostic Observation Schedule
ADOS-G	Autism Diagnostic Observation Schedule-Generic
AOSI	Autism Observation Scale for Infants
APSI	Autism Parenting Stress Index
ASD	autism spectrum disorder
ATEC	Autism Treatment and Evaluation Checklist
AuBC	Autism Behavior Checklist
BASC-2	Behavior Assessment System for Children-Second Edition
BISCUIT	Baby and Infant Screen for Children with aUtIsm Traits
BITSEA	Brief Infant – Toddler Social and Emotional Assessment
BSE	Behavioral Summarized Evaluation
BOSCC	Brief Observation of Social Communication Change
CARS	Childhood Autism Rating Scale
CASL	Comprehensive Assessment of Spoken Language
CBCL	Child Behavior Checklist
CFI	comparative fit index
CGAS	Children's Global Assessment Scale
CINAHL	Cumulative Index to Nursing and Allied Health Literature
COMET	Core Outcome Measures in Effectiveness Trials
COSMIN	COnsensus-based Standards for the selection of health status Measurement INstruments
CSBS-DP	Communication and Symbolic Behavior Scales-Developmental Profile
DSM-5	*Diagnostic and Statistical Manual of Mental Disorders*-Fifth Edition
DSM-IV	*Diagnostic and Statistical Manual of Mental Disorders*-Fourth Edition
EBD	emotional and behavioural difficulty
EFA	exploratory factor analysis
ERIC	Education Resources Information Center
ESCS	Early Social Communication Scales
GARS	Gilliam Autism Rating Scale
HSQ-PDD	Home Situations Questionnaire-Pervasive Developmental Disorders version
HTA	Health Technology Assessment
IB	Imitation Battery
ICC	intraclass correlation
ICD-10	*International Classification of Diseases*, 10th Edition
ICF-CY	International Classification of Functioning, Disability and Health for Children and Youth
IQ	intelligence quotient
M-CHAT	Modified Checklist for Autism in Toddlers
MCDI	MacArthur–Bates Communicative Development Inventories
MeASURe	Measurement in Autism Spectrum disorder Under Review
MSEL	Mullen Scales of Early Learning
NCBRF	Nisonger Child Behavior Rating Form
NIHR	National Institute for Health Research
OCLC	Online Computer Library Centre

PDDBI	Pervasive Developmental Disorders Behavior Inventory
PDD-NOS	pervasive developmental disorder – not otherwise specified
PDDRS	Pervasive Developmental Disorders Rating Scale
PEP-3	Psychoeducational Profile-Third Edition
PEP-R	Psychoeducational Profile-Revised
PIPS	Preschool Imitation and Praxis Scale
PLS-4	Preschool Language Scale-Fourth Edition
POEMS	Parent Observation of Early Markers Scale
PSI-SF	Parenting Stress Index-Short Form
QRS-F	Questionnaire on Resources and Stress-Friedrich Short Form
RBS	Repetitive Behavior Scale
RLRS	Real Life Rating Scale
RRB	restricted and repetitive behaviour
RRBI	restricted and repetitive behaviours and interests
SB5	Standard – Binet Intelligence Scales-Fifth Edition
SCATA	Social Communication Assessment for Toddlers with Autism
SCQ	Social Communication Questionnaire
SIB-R	Scales of Independent Behavior-Revised
SP	Sensory Profile
SRS	Social Responsiveness Scale
SSC	Sense and Self-Regulation Checklist
SSP	Short Sensory Profile
ToPP	Test of Pretend Play
VABS	Vineland Adaptive Behavior Scales

Plain English summary

The MeASURe (Measurement in Autism Spectrum disorder Under Review) project aimed to find the best tools, such as tests and questionnaires, to measure the progress of children with autism up to the age of 6 years.

First, we asked people what they thought it was important to measure. Parents, and children and adults with autism, told us that happiness, anxiety and sensory overload were most important. Health and education staff said they needed tools to measure areas of difficulty. This was because these are important when deciding whether a child has autism, and in finding out what things help them.

Next we found all of the published studies that tracked the progress of children with autism, to find out what tools researchers had used. Between them, these studies used 131 tools, so we then looked for studies that told us how good these tools were when used with children with autism.

We found tools that could be used to monitor some aspects of the progress of young children with autism but not all. There was little or no evidence about whether tools that describe children's social participation and well-being are useful for children with autism. We found good evidence for the usefulness of a small number of tools that measure autism characteristics and behaviour problems. When we showed these to parents and professionals at a Discussion Day, they pointed out flaws, such as unclear wording and crowded presentation of questionnaires.

New research is needed to improve this situation. Valued outcomes to assess include social communication skills, well-being and quality of family life.

Scientific summary

Background

Autism spectrum disorders (ASDs) are neurodevelopmental, lifelong conditions that are diagnosed using a set of behavioural criteria. ASD is common, affecting at least 1% of the child and adult population. The ASD early intervention literature is largely focused on the promotion of social communication skills and management of coexisting behaviour problems. One difficulty for the interpretation of research findings is the multitude of different measurement tools that have been used in collecting evidence of progress and outcomes. The tools are of varying relevance and with limited evidence of their measurement properties when used with young children with ASD.

Review questions and objectives

The aims of the MeASURe (Measurement in Autism Spectrum disorder Under Review) review were to identify the validity of tools and outcome measures used in measuring and monitoring young children with ASD, and to consider how well these reflect and measure issues of importance for patients and carers. To achieve this, our objectives were to:

- identify the tools reported in literature on quantitative research involving children with ASD up to the age of 6 years
- conduct a detailed systematic review of the measurement properties of tools within the major domains of development and functioning
- synthesise evidence regarding the most robust and useful tools in these different domains
- identify gaps in measurement of outcomes and make research recommendations.

These steps were undertaken in the context of understanding what people with ASD, and parents, thought should be measured, and their perspectives about some of the better tools.

Methods

Framework for what outcomes to measure

To consider the outcomes of importance for parents and other key stakeholders, we consulted with people with ASD, parents and professionals. We were guided by the evidence-based procedures for developing a core outcome set outlined by the UK Medical Research Council-funded Core Outcome Measures in Effectiveness Trials initiative. As ASD is complex, and the review needed to take account of the developmental context of measuring outcomes up to the age of 6 years, we placed the findings of the consultation stages in a conceptual framework to guide the full review of tools for measurement. For the MeASURe conceptual framework, there were four primary domains, with subdomains in each of impairments, activity level indicators, participation and family measures.

Understanding the views of people with autism spectrum disorder, parents and professionals around the measurement of outcomes that are of importance to them

We undertook the following steps:

- First, to identify the child- and/or family-specific outcomes that parents of children with ASD perceive as important, we undertook a scoping review of qualitative literature, using MEDLINE, the Cumulative Index to Nursing and Allied Health Literature (CINAHL) and PsycINFO (via Ovid).
- Second, we conducted a consultation – through groups and by e-mail – with young people on the autism spectrum regarding:
    - Outcomes – What do you think it is useful for health professionals and teachers to measure in young children (up to the age of 6 years) with autism?
    - Process – What is the best way of assessing these skills?
    - Where is the best place for observation to take place? What is it important for professionals to know about children with autism before they start to test them?
- Third, we undertook a survey through networks of health and education professionals to explore what constructs are most often measured by early years professionals in monitoring children's progress.
- Fourth, we consulted with parents at meetings (Exeter, London, Newcastle) on three occasions during the review process to establish which outcomes that parents consider to be most important.
- Finally, at the end of the review process, we held a discussion day with multiple stakeholders about the preliminary conclusions of the review, regarding what outcomes are important and how to assess them.

Systematic reviews

First systematic search

The *first systematic search* was undertaken to determine the range of tools used in observational and intervention evaluation studies in ASD, and relate these tools to the subdomains of the conceptual framework adopted for the MeASURe project.

Search strategy We included studies published from 1992 to coincide with the publication of the then-current international classifications, *International Classification of Diseases*, 10th Edition (ICD-10) and *Diagnostic and Statistical Manual of Mental Disorders*-Fourth Edition (DSM-IV).

Original searches were conducted in June and July 2012, and re-run in June and July 2013.

A total of 3059 papers were examined at full text and, from these, 255 papers were identified as appropriate for potential inclusion. There was a further stage of sifting of records found during the search of papers about measurement properties of tools, with searches completed by 9 September 2013. After exclusions, a total of 184 papers had information about tools extracted.

The following study types were included:

- all relevant randomised and quasi-randomised trials of early interventions
- cross-sectional and case–control studies of children
- descriptive cohort studies, including studies of baby siblings of children with autism, which provide information on tools to monitor developmental progress and follow early markers of ASD.

Child characteristics

We reviewed all studies in which at least 50% of children included had ASD operationalised as a 'best estimate' clinical diagnosis of ASD, including autism, ASD, atypical autism, Asperger syndrome and pervasive developmental disorder – not otherwise specified, according to either ICD-10 or DSM-IV criteria. All children were aged ≤ 6 years upon entering the study.

Types of measurement included

1. Direct assessment of child ASD symptoms by trained assessor.
2. Direct measurement of developmental skills, i.e. language, cognition, fine and gross motor skills, by trained assessor.
3. Observational measures of social interaction skills.
4. Interview or self-completed (parent, teacher or other professional) questionnaire report of child ASD symptoms.
5. Interview or self-completed questionnaire report of developmental skills – for example, language or adaptive skills – with/by parent, teacher or other professional.
6. Interview or self-completed (parent, teacher or other professional) questionnaire report of co-existing problems, including behaviour, aggression, sleeping, eating, toileting, anxiety, hyperactivity and others identified through parent consultation.
7. Idiographic measures focused on particular behaviours (e.g. goal attainment scaling, target behaviours).
8. Measures of impact on parent or family.

Types of measurement not included

- Economic impact on home and family.
- Experimental tasks and measures, for example barrier tasks, reaction time.
- Biophysical measures, medical investigations.
- Process measures.

Second systematic search

The *second systematic search* was undertaken to find papers that report the measurement properties of identified tools.

Not all tools identified for monitoring or outcome measurement could be searched for by name. First, a number of tools had been developed for a particular study (such as a coding system for parent–child interaction). Second, some tools were translations or adaptations of tools for use in another country, or had been used only up to 1994, and these were not pursued further for the purposes of this review. Original searches for papers describing measurement properties were conducted in March and April 2013, with follow-up searches completed in November 2013. The databases searched were Education Resources Information Center (ProQuest) – 1966 to present; MEDLINE (Ovid) – 1946 to present; EMBASE (Ovid) – 1988 to present; CINAHL (EBSCO*host*) – 1981 to present; and PsycINFO (Ovid) – 1987 to present.

In order to search for papers describing studies of measurement properties of tools, a specific search filter developed by the COSMIN (COnsensus-based Standards for the selection of health status Measurement INstruments) group was applied.

Each search consisted of four components: autism terms, age group terms, COSMIN filter and tool name. Searches were limited to English language only, and papers published from 1992 to present.

Inclusion criteria

1. Tool identified in first search was the focus.
2. Tool (or subscales) measured a domain from the 'conceptual framework'.
3. Study published as 'full-text original article'.
4. The study sample overlapped with the age range of 0–6 years.
5. The study sample could be individuals who were being monitored for ASD symptoms even if they had another primary diagnosis (e.g. a paper monitoring ASD symptoms in a Fragile X population could be eligible if exploring measurement properties of a tool used as an outcome).
6. The aim of the study was the development of a measurement tool or the evaluation of one or more of its measurement properties.

Exclusion criteria

1. Papers in which the measurement tool was tested only for its properties in diagnostic assessment or screening.
2. A sample drawn from only the general population of children.
3. Sample size of < 20.
4. With regard to papers on translated tools, if the purpose was simply to validate the translated version then it was not eligible. If the purpose was to explore the tool's validity in a different culture/country, the focus was on the properties of the tool and the findings appeared relevant for use in UK then it was included.

Results

Understanding the views of people with autism spectrum disorder, parents and professionals around the measurement of outcomes of importance to them

We found a striking difference between the constructs rated important by parents, and the constructs most frequently measured by health and education professionals. We found that parents' experience with their children leads them to emphasise outcomes such as child emotional well-being as affecting the whole family. Professionals acknowledged that they measure what they have the tools for, and that their practice is influenced by an emphasis on the core impairments in autism and behaviour that challenge, rather than necessarily seeing the broader picture and measuring how the child is affected by their environment. Thus the consultation did not produce, at this stage, 'consensus' across stakeholder groups about what outcomes are most important to measure in young children with ASD.

Systematic reviews to determine tools in use, and their measurement properties

Of the 132 named tools that were identified as eligible for inclusion in searches about papers on their measurement properties, no papers meeting inclusion criteria were found for 75 tools and therefore their measurement properties in use with children with ASD could not be examined further. Fifty-seven tools (43%) remained, for which evidence on measurement properties was obtained.

The detailed data extraction using the COSMIN checklist provided some positive evidence with regard to at least one measurement property for 41 tools (seven with various versions/editions) identified as being used to measure outcome at stage 2 of the review. The tools are grouped by primary conceptual framework domain:

Autism symptom severity: Autism Behavior Checklist; Autism Diagnostic Interview-Revised (ADI-R); Autism Diagnostic Observation Schedule (ADOS, including Toddler Module and Calibrated Severity Score); Autism Observation Scale for Infants; The Baby and Infant Screen for Children with aUtIsm Traits-Part 1

(BISCUIT); Behavioral Summarized Evaluation (BSE-R; including Revised and Infant); Childhood Autism Rating Scale; Gilliam Autism Rating Scale (GARS and GARS-2); Modified Checklist for Autism in Toddlers; Parent Observation of Early Markers Scale; Pervasive Developmental Disorders Rating Scale; Social Communication Questionnaire; Social Responsiveness Scale (SRS).

Global measure of outcome Autism Treatment and Evaluation Checklist; Pervasive Developmental Disorders Behavior Inventory (PDDBI).

Social awareness Imitation Battery; Preschool Imitation and Praxis Scale (PIPS).

Restricted and repetitive behaviour and interests Repetitive Behavior Scale-Revised.

Sensory processing Sense and Self-Regulation Checklist; Sensory Profile including Short Sensory Profile.

Language MacArthur–Bates Communicative Development Inventories (MCDI); Preschool Language Scale-Fourth Edition.

Cognitive ability Leiter International Performance Scale-Revised; Mullen Scales of Early Learning; Stanford–Binet Intelligence Scales-Fifth Edition.

Emotional regulation Baby and Infant Screen for Children with aUtIsm Traits-Part 2 (BISCUIT-Part 2); Children's Global Assessment Scale; Infant–Toddler Social–Emotional Assessment (including Brief form).

Play Test of Pretend Play.

Behaviour Problems Child Behavior Checklist (CBCL 1.5–5 and CBCL 6–18); Aberrant Behavior Checklist; BISCUIT-Part 3; Home Situations Questionnaire-Pervasive Developmental Disorders (HSQ-PDD) version; Nisonger Child Behavior Rating Form.

Global measure of functioning Behavior Assessment System for Children-Second Edition; Psychoeducational Profile-Revised (and Third Edition); Scales of Independent Behavior-Revised; Vineland Adaptive Behavior Scales (VABS; including Classroom and Screener versions).

Parent stress Autism Parenting Stress Index; Parenting Stress Index-Short Form (PSI-SF); Questionnaire on Resources and Stress-Friedrich Short Form.

The most evidence was gathered for tools that were developed especially for use with children with ASD. Content validity of these tools was accepted for this review as strong. Unfortunately, given the focus of the review, there was minimal evidence about which tools have capacity to track children's progress over time or in response to an intervention. In the case of standardised assessments (e.g. of language, cognition and play) and many questionnaires (e.g. assessing behaviour, attention and emotional regulation) developed for the general population, there was limited evidence of their measurement properties when used with or about young children with ASD. We found no evidence concerning tools that can describe and measure some of the aspects of children's social participation and well-being (valued by parents as important). Also, we have no evidence about measures of family quality of life, although there is some evidence about measures of parent stress.

Conclusions

The review has provided, for the first time, not only a list of tools used in measuring outcomes for children with ASD up to the age of 6 years, but also a systematic evaluation of their measurement properties and qualities. A tension between the diagnostic process in ASD, and the focus on parent and professional valued outcomes, was evident. The synthesis of evidence took into account the availability of tools, stakeholder views about the presentation of tools, the age range covered and the extent of the positive evidence about measurement properties in use with children with ASD. In summary, just 12 tools were considered the most valid overall; however, given their scope and limitations, these should not be considered a 'recommended battery'. These tools were ADOS; BSE-R; CARS; SRS; PDDBI; PIPS; MCDI; BISCUIT-Part 2 (co-occurring symptoms); CBCL; HSQ-PDD version; PEP; and the PSI-SF.

Research recommendations in order of priority

1. Development of a tool to measure child quality of life, with careful content validation for children with ASD.
2. Assessment of the measurement properties of a newly developed tool, the Brief Observation of Social Communication Change, by research group(s) in the UK, which has apparent promise as a primary outcome for early intervention trials focused on improving social communication in young children with ASD.
3. Further studies of the measurement properties of the VABS in young children with ASD in the UK.
4. Assessment of the measurement properties of the UK Early Years Foundation Stage Profile for use with young children with ASD.
5. Development of a questionnaire tool appropriate for young children with ASD to measure repetitive behaviour and circumscribed interests, which can be used across settings.
6. Assessment of the measurement properties of tools developed for young children with ASD which focus on problems such as anxiety and sleep.
7. Establishment of an agreed core set of outcomes to be measured in effectiveness trials of early intervention in ASD.

Study registration

This study is registered as PROSPERO CRD42012002223.

Funding

Funding for this study was provided by the Health Technology Assessment programme of the National Institute for Health Research.

Chapter 1 MeASURe: systematic review of tools to measure outcomes for young children with autism spectrum disorder

Introduction

Autism spectrum disorders (ASDs) are neurodevelopmental, lifelong conditions diagnosed using a set of behavioural criteria.[1] ASD is known to affect at least 1% of the child and adult population.[2–4] There is wide variation in the progress made by individuals with ASD, so that many individuals have significant lifelong needs for support. The burden and cost to the individual, family and broader society are very high, with the economic costs in the UK estimated to be £28B per year.[5]

In light of increased awareness about the prevalence of ASD, and the emphasis on early identification and diagnosis, it is important that health, education and social-care services provide evidence-based interventions and early support for individuals with ASD, and their families, carers and teachers. In the past decade there has been an increase in ASD intervention research, with recent improvement in the quality of studies.[6,7] The ASD early intervention literature is largely focused on promotion of social communication skills, with less emphasis on interventions for restricted and repetitive behaviours (RRBs). It also includes interventions focused on the high rates of co-occurring behaviours and problems (e.g. sleep, faddiness about food, aggression to others, toileting difficulties).[8,9] One problem for the interpretation of research findings is the multitude of different measurement tools that have been used in collecting evidence of progress and outcomes. Furthermore, longitudinal studies highlight the variation in individual developmental pathways.[10–12] The changes in prevalence are due, in part, to earlier recognition of ASD in children in the average range of ability, with likely effects on the pattern of outcomes.[13] The literature thus presents a large set of measures, inconsistently used, of varying relevance and with variable or indeed no evidence of their psychometric properties.

What should be measured?

There are several ways to consider the question of what to measure, including what government departments need in order to measure progress and outcomes, what matters to parents and individuals with ASD, and the theoretical basis of ASD, which has implications regarding important domains to measure.

The UK Chief Medical Officer's 2012 report focused on Child Health,[14] and discussed the poor educational, health and employment outcomes for children with neurodisability. In recent years, there has been consultation about the UK National Health Service Outcomes Framework 2011/12,[15] part of a strategy that aims to deliver 'the outcomes that matter most to people', using patient-reported outcome measures. The Kennedy report 'Getting It Right for Children and Young People'[16] highlighted the need to identify a common vision between families and professionals for what services are seeking to achieve for children. Measuring outcomes that are valued by families is central to that vision, which, in turn, will influence what services are provided and how, and potentially what services and interventions are prioritised for research evaluation. A recent National Institute for Health Research (NIHR) study has reported agreement on what are the valued outcomes of care for children with neurodisability,[17] but it is not clear whether or not these would be the same if a set of core outcomes were sought specifically for children with ASD.

The aims of our MeASURe (Measurement in Autism Spectrum disorder Under Review) review are to identify the validity of tools and outcome measures used in measuring and monitoring young children with ASD, and to consider how well these reflect and measure issues of importance for patients and carers (see *Appendix 1*). To achieve this we have:

- identified the tools reported in literature on quantitative research involving children of up to approximately 6 years of age with ASD (see *Chapter 3*)
- conducted a detailed systematic review of the measurement properties of tools within the major domains of development and functioning (see *Chapter 4*)
- synthesised evidence regarding the most robust and useful tools in these different domains (see *Chapter 5*)
- identified gaps in measurement of outcomes and made research recommendations.

An important part of the strategy has been to identify what people on the autism spectrum, and parents of children with ASD, think should be measured. As these stakeholders were involved at various stages throughout the project, there is no single section on 'patient and public involvement' in the report. Instead, parents and people on the autism spectrum have contributed particularly to *Chapters 2*, *5* and *6*. In *Chapter 2*, we address the issue of what outcomes should be measured.

Chapter 2 Development of the conceptual framework

Introduction

Within the MeASURe project, we carried out a series of consultations with stakeholders, including professionals, parents of children with ASD and people on the autism spectrum, and a scoping review of qualitative literature. The aim was to identify (1) what outcomes should be measured when monitoring the progress of young children with ASD and (2) whether there is agreement between parents and professionals about the relative importance of what to measure. The review of how to measure those outcomes in order to progress towards an agreed battery of tools is presented in later chapters. The chapter is structured to incorporate:

1. general considerations for developing a conceptual framework in ASD for the review
2. findings from scoping relevant qualitative research with families
3. consultation with people who are on the autism spectrum
4. survey consultation with professionals
5. consultation with parents
6. consultation with multiple stakeholders at a Discussion Day.

Valued outcomes

There exist recommended procedures for agreeing what should be a core set of outcomes in various fields of health care. As Williamson *et al.*[18] note, 'insufficient attention has been paid to the outcomes measured in clinical trials'. Consistency and interpretation will be improved if researchers always collect and report on core outcomes. The Core Outcome Measures in Effectiveness Trials (COMET) initiative funded by the Medical Research Council Network of Hubs for Trials Methodology Research aims to develop a set of evidence-based procedures for developing a core outcome set. The suggested steps involve:

- *Step 1* Agree the scope of the area of health care.
- *Step 2* Identify existing knowledge about outcomes.
- *Step 3* Involve key stakeholders, including patients and health-care providers.
- *Step 4* Develop consensus about what to measure. Techniques for doing this in an inclusive and objective way are outlined in Williamson *et al.*,[18] including how to determine when consensus has been achieved.

A systematic review of studies that aimed to determine which outcomes to measure in clinical trials in children concluded that in most specialties no research had been undertaken.[19]

The scope for this review was determined in the Health Technology Assessment (HTA) commissioning brief (i.e. COMET step 1) and includes a potentially broader use of outcomes than only in trials. This chapter presents the work undertaken on steps 2 and 3, i.e. to identify priorities for child outcomes as valued by parents and professionals, and as explored in qualitative literature. Because of the complexity of ASD as a disorder, and the developmental context of measuring outcomes up to the age of 6 years, the MeASURe review adopted a further step of placing the findings of the consultation stages in a conceptual framework to guide the full review of tools for measurement. This framework also guided further consultation with stakeholders about the relative importance of outcomes to measure. MeASURe did not undertake a further formal process to develop consensus (step 4 above). It may be that 'consensus' would be hard to achieve but it would require further procedures. In principle, the choice of outcomes to focus upon depends on the specific research question being asked, and on what is important to particular groups of stakeholders.

Considerations for developing a conceptual framework in autism spectrum disorder

One important potential basis for a conceptual framework for valued outcomes for children with ASD is the International Classification of Functioning, Disability and Health for Children and Youth (ICF-CY),[20] so that what is measured can be 'mapped' against domains of functioning (e.g. Learning, Communication, Self-Care) and participation (e.g. Relationships, Community Life).

The conceptual framework should also be influenced by an understanding of ASD. The behavioural characteristics of ASD are underpinned by genetic, brain structure and neuropsychological differences from typical development.[21] The conclusions of many studies have led to the revision of the *Diagnostic and Statistical Manual of Mental Disorders*-Fifth Edition (DSM-5) published in May 2013, such that the impairments in ASD are best considered within two groupings: social/communication difficulties and restricted/repetitive interests and behaviours, including hypo- or hyper-responsiveness to sensory stimuli. The aetiological underpinnings for each of these broad domains of impairments may be different, and both may be targets for interventions targeting 'core' features of autism.

Another aspect of complexity in the understanding of ASD is that its measurement is affected by developmental considerations, i.e. children's profile of skills and difficulties may look very different over time, and those trajectories will also be affected by levels of ability. As an obvious example, we cannot measure children's social ability to make and keep friendships with validity until they are of an age at which that might be expected in typical development. However, there is some recent agreement on the core early impairments that may be observed. By the age of 2 years, differences in the development of children with ASD (from typically developing children and those with developmental delay) are evident in behaviours such as fearfulness, frustration and lack of co-operation, quick mood changes, and fine and gross motor skills.[22] This knowledge has been enhanced by recent studies of the early development of baby siblings of children with autism (who have an increased chance of themselves developing ASD); for example, Zwaigenbaum *et al.*[23,24] reported unusual eye contact, a lack of visual attention, orientating to name, imitation, social interest and emotional affect, and heightened sensory-orientated behaviours. These combinations of deficits have consequences for development of relationships, early language and play, and, in turn, for the content and targets of early intervention.

The complexity of understanding ASD is made even greater when considering the interaction between domains of development, and how deficits in one may impact upon another; for example, visual sensory overload may lead to avoidance, which reduces opportunities for visual learning and social experience, leading to poor social skills. Furthermore, there is evidence that pragmatic skills (such as social timing in interaction) are closely associated with particular types of behavioural profiles.[25,26] Thus the conceptual framework for a review of outcome tools should consider both measurement of individual areas of functioning, which are likely to change over time, and also tools that bring together these separate areas into a more holistic assessment. It is particularly important to be able to create profiles for children with ASD, who often have difficulties in generalising learning between areas of skill and also generalising skills from one setting to another.

It is also important to detail other associated difficulties that are not unique to ASD but which, nevertheless, can play a major part in children's development and the burden of care for families. These commonly include feeding and eating difficulties (resistance to certain food textures, faddiness about types and colours of food, etc.), behaviour and sleeping problems. Children who lack adequate nutrition and sleep are likely to be bad tempered and even more rigid in their thinking and behaviour. Furthermore, adaptive functioning may be more impaired in children with ASD than would be expected from their level of ability. Finally, as young children's development is intimately affected by their environment, including the health, skills and resilience of parents and carers, it is important to include consideration of the impact on the family.

Although the conceptual framework developed over the process of consultation, and was informed by the separate activities described below, it is presented first for brevity and clarity (*Table 1*). The framework

TABLE 1 Conceptual framework for the MeASURe review

Domains	Subdomains	Constructs of interest
Body Functions and Structures/Impairments	Symptom severity	Change in diagnostic category; autism severity; diagnostic scores used as measures of outcome
	Social awareness	Joint attention skills; imitation; social attention
	Restricted, repetitive behaviour	Repetitive, stereotyped movements; repetitive use of objects; repetitive use of language; attention to detail; insistence on sameness
	Sensory processing	Hypersensitivity; hyposensitivity
	Language	Expressive language; receptive language; gestures
	Cognitive ability	IQ/developmental quotient; non-verbal ability; verbal ability/reasoning
	Attention	Distractibility; impulsivity; hyperactivity
	Emotional regulation	Happiness; irritability; distress; anxiety
	Physical skills	Poor co-ordination/gross motor skills; fine motor skills
	Physical indicators	Tics; gut/bowel symptoms; nutritional status; height and weight (growth); effectiveness of medication; adverse effects of medication; vaccination rates
Activity-Level Indicators	Social communication	Frequency/quality of initiations; pragmatics
	Social functioning	Attachment; interaction skills with other children; awareness of others' emotions
	Play	Levels of play (exploratory to symbolic); organises own time/activities
	Behaviour	Maladaptive behaviour; tantrums/meltdowns; aggression; self-injury
	Habit problems	Sleep latency and waking; eating problems; toileting problems
	Learning	School readiness; early literacy; early numeracy
	Daily living skills	Feeding self using cutlery; dressing self
	Global measure of function	
	Global measure of outcome	
Participation	Social relations	Sibling relationship; friendships; attending family events; attending birthday parties
	Subjective well-being (quality of life)	Coping/resilience; self-esteem
	Social inclusion	Social participation; social exclusion; difficulty with attending appointments; awareness of danger
Family Measures	Interaction style	Synchrony; shared attention
	Parenting	Parent firm and fair; parent warmth to child
	Parent stress	Parent stress; parent coping style; parent anxiety and depression
	Family quality of life	Impact on family; family cohesion

IQ, intelligence quotient.

adopted was informed by discussion within the project team, and inspection of other relevant frameworks such as groupings of target symptoms/skills from interventions studies in ASD,[20,27] education outcomes,[28] grouping of interventions by Research Autism (http://researchautism.net/pages/autism.treatments.therapies.interventions/) and compilation of measures for children with developmental disabilities.[29] One area discussed was how to categorise quality of life, which is essentially a construct separate from the ICF-CY. The decision was made to include it in the participation domain, as it implies how an individual interacts with their environment.[30] For the MeASURe conceptual framework, there are four primary domains, with subdomains in each.

Scoping review of qualitative literature (BB, NL, CM)

Question

What child- and/or family-specific outcomes do parents of children with ASD perceive as important?

Methods

Search strategy

A systematic search was conducted (7 June 2012) using:

- MEDLINE: 1948 to current
- Cumulative Index to Nursing and Allied Health Literature (CINAHL): 1937 to current
- PsycINFO: 1806 to current.

Blocks of search terms were assembled for ASD (block 1) and Qualitative Study Designs (block 2), tailored to each database (see *Appendix 2*).

Papers were selected if they identified themes concerning parents' aspirations or desired outcomes for their children, experience of assessment of their children, and their priorities for intervention for, and education of, their children. Papers were excluded if (1) ASD was not outlined in the paper as a specific focus (e.g. if 'developmental disabilities' were the conditions of interest); (2) they did not involve parents (e.g. a paper interviewing parents and teachers would be included; a paper interviewing just teachers was excluded); (3) the focus was on parents' views and hopes for their adult children with ASD (e.g. focus must be on parents/carers of young children); and (4) the paper was not in English.

Abstracts and titles of references retrieved by the electronic searches were screened for relevance by one reviewer only (NL); two reviewers (BB, CM) then screened these titles and abstracts, and retrieved full texts for included papers.

Data synthesis

In order to present an overview to the parent advisory groups and the research team, key findings (including illustrative quotes) and analytical frameworks from each paper were extracted and tabulated, and themes identified.

Results

Searches identified 102 relevant papers. Fourteen studies were selected as sufficiently relevant to obtain a full text of the paper. Three of these were excluded because they did not collect qualitative data on outcomes; four were excluded because they contained no data on outcomes. Seven articles remained.

It was clear from an initial inspection of these articles that the quality of data was variable and ranged in focus/topic. Three articles reported data relevant to only parent outcomes,[31–33] including process outcomes. Three articles reported data relevant to child outcomes only[34–36] and one reported both.[37] One study included data collected directly from children and young people with ASD,[34] although original quotes from children were not presented.

The age range of children represented in these studies was 0–21 years. Just two studies[31,33] focused specifically on younger children (3–6 years;[31] up to 5 years[33]). The diagnoses represented in the studies typically relied on parental reports. Two studies[35,37] focused on particular diagnostic groups (Asperger syndrome;[37] ASD with no functional communication[35]) and others were defined in terms of use of a particular service (speech-and-language therapy;[31] assessment and diagnosis;[32] preschool educational intervention[33]).

Data collection methods included focus groups, individual face-to-face interviews and open-ended/free-text questions within postal and web-based surveys.

Although we did not appraise quality of studies formally (using any standard checklist), the quality of reporting sampling and recruitment, data collection methods and data analysis processes was extremely variable.

Given the significant limitations, in terms of quality and relevance, a 'light touch' data extraction was undertaken to identify outcomes and themes (see *Appendix 2*).

In terms of child outcomes, it was notable that some aspects deemed 'fundamental' by parents may not be regularly assessed (such as 'safety'),[34] and certainly not as an outcome of an early intervention trial. 'Awareness of danger' was added to the conceptual framework (subdomain Social inclusion) as a fundamental issue of safety. The parents' and young people's emphasis on participation outcomes (such as being 'isolated from peers' or 'live a normal life') may also not be reflected in what is usually measured. Constructs concerning child and parent stress, and positive mental health[36,37] were supported as important to include as outcome constructs in the conceptual framework.

In addition, parents often highlighted the processes of interaction with professionals, and the utility of information from assessments. Parents expected the service to provide them with information and research literature; to involve them in decision-making processes; and to teach parents how to deliver therapies at home.[31] Braiden *et al.*[32] reported that parents 'desired information relevant and applicable to their child to assist them in understanding and making sense of their own child's presentation'. They also mentioned wanting to have positive times with their child: 'when he is behaving well and not gearing up for a fight, he's a very happy and pleasant child'.[37] Such parent priorities have informed the conclusions of the MeASURe project.

Consultation with people on the autism spectrum (DG, GJ)

Questions

Outcomes

What do you think it is useful for health professionals and teachers to measure in young children (up to the age of 6 years) with autism?

Process

What is the best way of assessing these skills? (observation; asking parents; testing the child; asking the child questions)

Where is the best place for observation to take place? (home; school; clinic; other)

What is it important for professionals to know about children with autism before they start to test them?

Methods

People on the autism spectrum in Birmingham and Newcastle were approached for their opinions by a person they knew well. In Birmingham, six adults were known to the University and responded by e-mail; 10 children were approached by a member of the Autism Outreach Team and were selected on the basis that they were thought able to give their views on the questions. In Newcastle, two children attending a National Autistic Society social group responded in person and, likewise, two young adults attending a social inclusion group. Responses to the questions were thus received from 12 young people aged 9–15 years, and from eight adults aged 22–43 years. Each respondent was given a shopping voucher in acknowledgement of their contribution. The verbatim responses were collated and common themes extracted.

Results

Outcomes

Responses showed that young people had a good knowledge of the areas that were likely to be affected in autism (e.g. eye contact, social skills and communication) and those likely to be measured (e.g. intellectual level). However, some of the respondents emphasised outcomes that may not usually be prioritised by professionals or researchers (the subdomains into which these suggestions fit are shown within parentheses):

- How they respond to change in their lives (Restricted, repetitive behaviour); whether they are unhappy in a room because it might be dirty (Restricted, repetitive behaviour; Sensory processing); ability to sit still – if fidgety (Attention); whether they get angry easily (Emotional regulation); whether they like talking to people (Social functioning); how long it takes for information to stick (Learning); ability to make friends (Social relations); do they hang around with popular kids so that they are popular? (Social inclusion).

Areas that were mentioned most often by the adults as important to assess included special interests and sensory issues, and social interaction to a lesser extent. Some respondents stressed the importance of trying to understand the rationale for a young child's repetitive actions or special interests.

Process

Many of the respondents emphasised the need to observe children, and for that observation to take place in more than one setting, as behaviour may be very different in different places. Tests (i.e. series of standard tasks) might be 'alright' if they are interesting, and given in manageable-length sessions. Some adults on the autism spectrum were concerned that the use of normed tests or checking against typical milestones leads to negative conclusions, because developmental trajectories of children on the autism spectrum may be atypical and strengths may be missed. Respondents suggested that those administering tests should not assume instructions are clear and have the same meaning for a child with ASD, and that testing should happen in a place where the child is comfortable.

Respondents expressed the view that people who do assessments should find out about children before assessing them. One child said: 'Ask the child to show them what they like to do, e.g. jigsaws, lego'. They also felt that parents and support staff should be asked about special interests, motivators, sensory issues, and so on, and also about any events that have happened recently which may be affecting the child. One adult emphasised the need to be mindful of a child's self-esteem: 'So much of the time assessment is done in terms of measuring deficits against a supposed "normal" or "ideal" . . . I had a feeling of being 'different' or 'wrong' from approximately the age of 3 years'.

Survey of professionals working with early years children with autism spectrum disorder (GJ, JRP)

Question

What constructs are most often measured by early years professionals in monitoring children's progress?

Methods

A survey was undertaken in autumn 2012 through the British Academy of Childhood Disability database of 240 UK Child Development Teams. Professionals were sent an electronic link to a web-based survey that took 10 minutes to complete. In parallel, education professionals received the survey via (1) '4 Children', a national charity and UK Government strategic partner for early years and child care, through their database of 15,000 Early Years providers across England; (2) the database of an independent specialist centre for early years children with ASD; and (3) 150 practitioners undertaking the Birmingham University School of Education Autism Programme residential weekend.

The survey had five sections. Respondents were asked:

1. About their profession, and the setting in which they work.
2. 'Do you regularly work with children on the autism spectrum (this includes any activity that aims to improve/change an area of functioning)?' and 'Do you ever measure the progress or outcomes of children on the autism spectrum (i.e. more than just seeing the child once for assessment)?'. Those who indicated 'yes' were given access to the rest of the questions.
3. To identify all areas in which they formally measure or informally make judgements about progress or outcomes for children on the autism spectrum whom they see more than once, and who are aged ≤ 6 years. The 68 outcome constructs included were taken from the conceptual framework.
4. To indicate how frequently (on a six-point scale) they used different types of tool: standardised measures of progress or outcome (with manual and comparative age-related information); non-standardised measures (either published or created locally); informal judgements.
5. To give the three areas in which they most frequently measure progress over time, or outcome, with which of the three types of tools.

Results

The 836 respondents included 167 health professionals (paediatricians, speech-and-language therapists, clinical psychologists, occupational therapists, physiotherapists, dietitians, health visitors, social workers and educational psychologists), 353 education professionals (teachers, special educational needs co-ordinators, autism education advisors, teaching assistants, intervention practitioners), 125 nursery nurses and 191 other professionals, many of whom were childminders. Professionals worked in a variety of settings. Many health professionals worked in child development centres or hospitals but some were based mainly in educational settings. Education staff were from mainstream and specialist schools or early years settings.

Five hundred and thirty-seven professionals monitored the progress or outcome of children who were seen more than once, and were able to access the remainder of the survey.

Professionals were more likely to measure characteristics such as amount of speech (76%), social interaction (90%) and attention (79%) than life or adaptive skills (measuring for, or trying on, clothes 6%, difficulties with appointments, e.g. hairdresser, dentist 16%, use of knife and fork 29%), features related to 'quality of life' for the child (quality of life 21%, happiness 42%) or the family (nature of sibling relationship 18%, family quality of life 22%, impact on the family 33%).

Professionals were more likely to use their 'own informal judgement in discussion with parents or other professionals' than standardised measures to rate improvements (442 respondents agreed with 'used often', 'most of the time' or 'always' compared with 253 who checked 'never', 'rarely' or 'sometimes'). The specific types of measures used varied very widely due to the broad range of professional respondents.

However, consistently across the questions, around one-third of respondents replied that they used standardised measures, and half said that they were most likely to use parent or professional impression to gauge progress or outcome. (The standardised tools identified as used most frequently were later included in searches in *Chapter 4*.)

In conclusion, this survey found that professionals are most likely to measure features related to core impairment subdomains of autism, rather than aspects of daily living, family functioning, and child well-being and happiness.

Consultation with parents (DG, PG, AS le C, CM)

Question

What outcomes do parents consider as important to be assessed?

Methods

Parent advisory groups were recruited at three sites (Exeter, South London, Newcastle). In Exeter, the Peninsula Cerebra Research Unit involves families of disabled children as partners in research through a Family Faculty.[38] Parents of children with ASD were e-mailed and invited to volunteer: 12 expressed interest and seven participated in one or more meetings. In London, the Newcomen Neurodisability Team involves families of children with ASD in giving advice on an ad hoc basis; for MeASURe, 10 parents were invited by e-mail and six participated in one or more meetings. In Newcastle, parents of children with ASD aged ≤ 10 years were invited by e-mail; four participated in one or more meetings. Thus a total of 17 parents were involved in discussion meetings. Parents were given a financial acknowledgement in addition to travel expenses, to recognise their time and expertise at each attendance. Meetings were held at three points during the MeASURe project.

Early meeting To explore parents' priorities and experiences of assessment and identify what outcomes parents saw as important, especially for monitoring their young child with ASD over time. This session involved an explanation of the aims of the project and open discussion, led by a member of the project team and a parent involvement co-ordinator.

Mid-point meeting To undertake a Q-sort of constructs emerging from the conceptual framework. Two members of the MeASURe project team (NL, GM) created 'lay wording' versions of the constructs. Sixty-two constructs were presented on cards in a jumbled order (i.e. not including symptom severity, physical indicators, global measure of function, global measure of outcome). The way in which the constructs had been chosen was introduced by the project team member. Through discussion within the parent group, the constructs were sorted on to a 'forced-choice' grid in a pyramid shape on a large piece of paper. Columns on the grid were rated for levels of importance (from 'more' to 'less' on an 11-point scale), i.e. 'the importance of various things which could be measured when tracking the progress of children with autism aged up to 6 years, or in measuring the outcome of a specific preschool intervention'. It was stressed that none of the constructs was considered unimportant.

End-point meeting Parent groups met again to consider a summary of the findings of the literature reviews and early consultations. This included a question about the reasons for differences between what parents consider important to be measured and what professionals most often measure. The main activity was to examine five questionnaires that had been rated positively in the systematic reviews. Parents were asked to compare and contrast two questionnaires about parent stress, two questionnaires about children's behaviour problems, and one questionnaire designed as a global measure of outcome. The issues raised were then taken by parent representatives to the MeASURe project Discussion Day on 14 February 2014 (see *Chapter 2*, *Consultation with multiple stakeholders*).

Results

Early meeting

Parents expected that professionals would focus on assessment of core features of autism, such as communication and social interaction. However, they suggested that the child's skills should be acknowledged and more attention be paid to unusual behaviours that the child is exhibiting, as well as measuring what the child is not achieving. For parents, priority areas for measurement included habit behaviours (such as sleep, diet and food-related behaviours, sensory processing issues, toileting) and also challenging behaviours and 'meltdowns' (such as self-harm, hitting out, anxiety, stress, happiness, tics). Parents endorsed the importance of social communication and social functioning (interacting, playing with others, playing alone, understanding and communicating) and, furthermore, the building blocks of learning, independence and life skills (reading and academic achievements, hobbies and sport, imagination and creativity, self-care, preparing food, getting dressed, time management, vulnerability and danger). They also stated that they recognised that some activities/skills may not seem that important or be seen as relevant for this young age range but become a more significant priority later on in development and as their child progresses through school. Parents also mentioned difficulties they had with taking children to appointments for health care (vaccination, dental care, shoes, eyes and hearing). These constructs influenced the conceptual framework, and the content of the survey for professionals.

Parents also commented on aspects of the process of assessment. They recommended the use of video in relaxed environments, so that professionals may watch for changes. They stressed the value of information gathered in a range of settings (suggesting use of video to rate change over time and between different settings). *Figure 1* illustrates the themes arising from one of the parent group meetings.

Mid-point meetings to undertake the Q-sort

There were four groups that completed this task (two in London to accommodate parents' availability). Taking an average of the Q-sort ratings from all sites, the items rated on average as 'more important' can be grouped as:

- *Body functions/impairments* Hypersensitivity, anxiety, unusual fears, distress, non-verbal ability, expressive and receptive language.
- *Activity level indicators* Aggression, sleep problems, school readiness.
- *Participation* Happiness, self-esteem, relationships with brothers and sisters, being bullied/rejected, no awareness of danger.
- *Families* Parent stress.

The highest level of consistency in rating these constructs across groups was for aggression and sleep problems. Parents rated happiness as important for all young children but one group did not agree that this could be considered an ASD-specific measurable outcome. In discussion parents mentioned that they had had to learn about autism, and so had not understood at the start of assessments of their child why skills such as 'joint attention' were of importance.

End-point meetings

In London it was not possible to arrange an end-point meeting; there were a number of barriers for parents' attendance including 'travel time', 'difficulties getting child care' and 'need to battle the new school statementing system'. In Exeter, a preliminary meeting was held to discuss with parents how to assess the strengths and weaknesses of tools used in assessment (i.e. explanations of terms such as reliability, validity and sensitivity to change).

Within the preliminary report, the ratings on importance by parents were compared with the constructs most often measured by professionals (*Table 2*), and parents were asked to reflect on the differences.

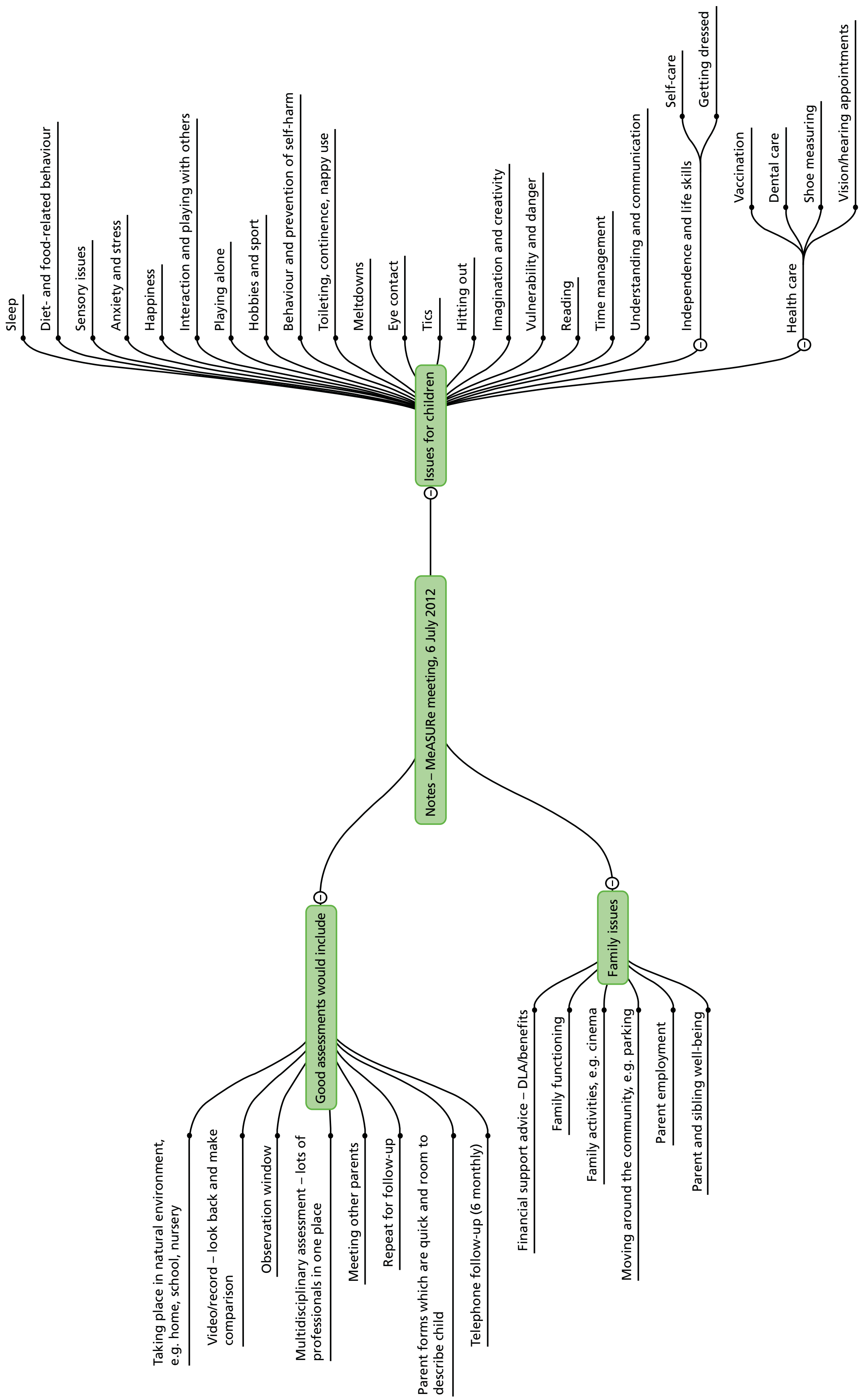


FIGURE 1 Themes from Exeter parent group discussion. DLA, Disability Living Allowance.

TABLE 2 Difference between professionals and parents on their top 10 constructs for measurement of progress or outcome

Professionals: areas regularly measured	Parents: important areas to measure (rank)
90% social interaction with children	Happiness (1)
84% play skills	Anxiety, unusual fears (2)
79% attention	Positive views of self (self-esteem) (3)
76% amount of speech	Distress (4)
75% understanding of language	Non-verbal ability (5)
73% expressive communication skills	Relationships with brothers and sisters (6)
72% pretend play	Parent stress (7)
70% fine motor skills	Fighting, hitting others (8)
68% participation in activities	Sleep problems (9)
68% challenging behaviour	Being rejected by others (10)

The only area of overlap between parents and professionals was ‘challenging behaviour’/’fighting, hitting others’. Parents in Newcastle highlighted that they believed that parents tend to focus on broader outcomes than professionals, as they see their children everyday in different environments. Anxieties and distress were emphasised; parents remarked that it is emotional needs that impact on the child’s and family’s quality of life. Parents also believe that professionals tend to be unaware of these important difficulties before a child enters the social environment of education.

The Exeter parents had a rather different way of viewing the table. They suggested that professionals measured aspects that were intermediate outcomes, which facilitate what parents rate as important. For example, they suggested that parents’ identification of ‘fighting, hitting others’, ‘distress’, ‘happiness’ and even ‘parent stress’ could be mapped from what the professionals highlighted as ‘challenging behaviour’. Similarly, when parents highlighted ‘relationships with brothers and sisters’, these benefited from adequate ‘speech’ and ‘understanding of language’. So, despite the different labels, there was general support from parents for what professionals measure, and parents had noticed their children making progress in these areas.

Consultation with multiple stakeholders

Question

What outcomes is it important to assess when monitoring the progress and outcomes for children with ASD up to the age of 6 years?

Methods

A Discussion Day was held in London on 14 February 2014. Twenty-five participants were invited: four parents of children with autism; three young people with autism, two of those with staff who support them in education; eight speech-and-language therapists, occupational therapists, paediatricians or psychologists; and two researchers working with children with autism; six MeASURe project researchers who work in health or education services also attended.

As one activity, groups of similar background carried out a further Q-sort to rate the importance of constructs, and ascertain similarities or differences between what parents, professionals and researchers consider most important. The set of 21 constructs for the parents and for the young people was drawn primarily from those reported as most often assessed by the early years professionals in the survey. The set for the professionals and the researchers included the 10 rated as most important by the parent groups, and the 10 most often measured by professionals as reported in the survey. Both sets were completed with added constructs to represent a wide span of subdomains.

We hypothesised that:

- The young people and parents might well agree on the top 10 constructs.
- The professionals might also agree with parents, even although what they actually measure is not in accordance.
- The researchers might choose a different set (more based on intervention elements, symptoms and everyday function).
- We had no expectation about parents' views on the order of importance of what professionals tend to measure.

Results

Adverse weather conditions and train cancellations prevented several participants joining the Discussion Day, including two young people on the autism spectrum. However, four groups of four people each considered the constructs.

One young adult on the autism spectrum joined the parent group; his/her ranking showed a high level of agreement with the averaged ranking of constructs undertaken previously by parent groups (Spearman rank correlation $r_s = 0.618$). Fine motor skills were rated higher than previously because of the experiences of the young adult as a child. 'Friendships' was rated higher than previously, reflecting on the precursor skills needed by the child early on that will lead later to being able to make friendships. Aspects that affect the emotional state of the child, including sensory processing, continued to be rated highly. 'Participates in mainstream activities' was rated low: the group thought 'this means the ASD child has to adapt to the mainstream world rather than 'mainstream' adapting/understanding/respecting ASD needs'. They also gave a low rating to 'not cooperating, throwing, spitting, won't sit (challenging behaviour)', as they considered it the role of adults (parents, education and care staff) to try to make the environment right for the child so his/her autism was less 'disabling'.

The two multidisciplinary groups of health and education professionals, and the group of ASD researchers, had low agreement with the averaged ratings of the parent groups ($r_s = -0.268$, 0.131 and –0.063, respectively). The health and education professionals commented that they measure what they can (in the setting, given the available tools) and what they traditionally have done. They emphasised as 'important' what they see as most urgent to try to change, such as challenging behaviour and communication skills. In contrast, although acknowledging the importance of the construct 'positive views of self (self-esteem)', they gave it a lower rating because of the developmental stage of children up to 6 years; researchers similarly rated self-esteem as low because of the lack of a suitable measurement tool. The researchers had rated highest 'not cooperating, throwing, spitting, won't sit (challenging behaviour)' on the basis of its impact on others and on the child's experience. Both groups of health and education professionals identified a range of additional constructs that they would consider it important to measure, including communicative competence, problems with food, functional adaptive behaviour, etc. They also mentioned the importance of identifying the skill set of support staff, and parent confidence in managing their child's needs and behaviours.

When all groups came together, the discussion highlighted differences in perspective, in summary a 'social' model and a 'medical' model. The parents and the young adult on the autism spectrum argued that it is important to focus on what children *can* do, to see autism as a 'difference' rather than always use a 'deficit' model, and to focus more on how to enable children through improving their environments. Parents were encouraged that the clinicians had mentioned including assessment of the skills of care and education staff. The clinicians reflected that their approach to assessment and intervention is based on a more 'medical' model: early identification of specific impairments, treatment, prevention of secondary impairment, and so on. The measurement of outcomes and tools available reflect this framework, with an emphasis on problems and deficits. For the researchers, the model of intervention and outcome assessment was also primarily embedded in a 'deficit' model of autism, with an emphasis on treating and measuring core features of autism. Research outcomes such as helping parents manage better and understand more are seen as 'soft outcomes', and not given the same importance as changing children's characteristics. A certain contradiction was pointed out between the recognition that publicly funded research must now be informed by good patient and public involvement, and yet the priority research questions, commissioning briefs and frameworks for judgement of what is good science do not necessarily value the social model of understanding a condition such as ASD.

Overall conclusions

The MeASURe project took a multifaceted approach to consultation. We aimed to identify (1) what outcomes should be measured when monitoring the progress of young children with ASD and (2) whether there is agreement between parents and people with ASD on the one hand, and professionals on the other hand, about the relative importance of what to measure. The initial stages of the review of qualitative literature, and the early parent advisory groups, added to the conceptual framework developed to guide the project. That framework of four domains and 26 subdomains appears to cover the constructs valued by various stakeholders, and enabled similarities and differences in perspective to be elicited.

We found a striking difference between the constructs rated important by parents and the constructs most frequently measured by health and education professionals. In discussion it became clear why this would be likely. Parents' experience with their children leads them to emphasise emotional well-being as affecting the whole family. Professionals measure what they have the tools for, and acknowledge that their practice is influenced by an emphasis on the core impairments in autism and the behaviour of the individual child, rather than necessarily seeing the broader picture of how the child is affected by their environment. Thus the consultation has highlighted the need to include information from multiple sources to reflect the complementary perspectives of the different stakeholders. This greater awareness of contrasting perspectives has enriched the discussion of available tools (see *Chapter 5*). Furthermore, parents and young people highlighted critical points about the process of assessment and monitoring of young children with ASD which also contributed to the evidence synthesis.

Chapter 3 Systematic search of observational and intervention literature

Introduction

In preparation for the MeASURe project, an initial scoping search of published systematic reviews of intervention in ASD was conducted (in May/June 2011 by NL); this identified eight Cochrane Collaboration reviews and 13 recent journal papers. The scoping search enabled us to gather information regarding tools that are commonly used to measure outcomes, and to identify theoretically important gaps in the domains measured. This scoping search was not limited to children up to 6 years of age. Seventy-nine tools were reported in the reviews, including 23 assessing adaptive and maladaptive behaviour; 17, language/communication; 13, ability; eight, sensory; nine, ASD specific; four, impact on family; two, social interaction; one, motor skills; and two, summary scales.

Many of the reviews failed to discuss the relevance of the outcome domains, and the strengths and weakness of the included tools – those that did were relatively consistent in their recommendations for improvement. The domain most commonly cited by review authors as missing was 'quality of life'.[39–41] Other missing outcomes included 'school readiness', 'independence and daily living skills'[39] and 'behavioural outcomes' such as sleep disturbance, self-mutilation, attention and concentration problems.[40] Also mentioned was the need for qualitative research to determine which outcomes are 'useful and relevant to consumers, clinicians and service providers'.[41]

A key limitation mentioned in the reviews concerned ASD-specific tools, developed to aid diagnostic assessment, but used to monitor change, even although not designed and validated for this purpose.[40–42] Similarly, intelligence quotient (IQ) has been used as a measure of change although designed to measure a 'stable' construct.[43] Two further unresolved questions are first how parents (and other stakeholders) define an important change, and, second, what magnitude of change should be considered clinically relevant (and therefore used as the target difference in intervention studies).[40–42]

Several review teams commented that included studies had measured outcomes using unpublished or non-standardised measures.[8,43,44] Some reviews included studies focusing on anecdotal reports or ad hoc questionnaires created by the researchers for that specific study[45] and not adequately validated.

Finally, one prominent recommendation common to all reviews was the need for a core shared battery of baseline assessment and outcome measurement tools, although the challenge of developing a single battery was recognised, because of the heterogeneity of children's difficulties, developmental ability and trajectory of developmental change.[46] Some reviewers proposed specific key domains that they felt should be considered, including intellectual ability, developmental abilities across domains, adaptive behaviour, communication skills, severity of autism, play, social skills, challenging behaviours, rigidity and other behaviours that are characteristic of children with autism.[40,47]

Review of tools in use

The purpose of this systematic review was to identify the range of tools used to date in observational and intervention evaluation studies, and relate these tools to the subdomains of the conceptual framework adopted for the MeASURe project.

Review question

What tools are in use for measuring and monitoring developmental outcomes in young children with ASD?

Search strategy

We included studies published from 1992 to coincide with the publication of the international classifications, *International Classification of Diseases*, 10th Edition (ICD-10) and *Diagnostic and Statistical Manual of Mental Disorders*-Fourth Edition (DSM-IV).[48,49]

Original searches were conducted in June and July 2012, and re-run in June and July 2013. The databases searched were:

- Applied Social Sciences Index and Abstracts (ProQuest) 1987 to present
- Cumulative Index of Nursing and Allied Health (CINAHL) (EBSCO*host*) 1981 to present
- The Cochrane Library [includes Database of Abstracts of Reviews of Effects, HTA, Cochrane Central Register of controlled Trials, Cochrane Database of Systematic Reviews (Ovid)] inception to present
- Education Resources Information Center (ERIC) (ProQuest) 1966 to present
- MEDLINE (including In-Process and Other Non-Indexed citations) (Ovid) 1946 to present
- EMBASE (Ovid) 1988 to present
- PsycINFO (Ovid) 1987 to present
- Sociological Abstracts (ProQuest) 1952 to present
- Linguistics and Language Behavior Abstracts (ProQuest) 1973 to present
- Health Management Information Consortium (Ovid) 1979 to present
- PapersFirst [Online Computer Library Centre (OCLC)] inception to present
- Proceedings (OCLC) inception to present
- Scopus, inception to present
- Social Services Abstracts (ProQuest) 1979 to present
- Web of Science (Science Citation Index, Social Sciences Citation Index, Arts and Humanities Citation Index and Conference Proceedings Citation Index inception to present)
- WorldCatDissertations (OCLC) inception to present.

Additionally, grey literature was searched via Digital Education Resource Archive, Oxford Patient-Reported Outcomes Measurement database, Turning Research into Practice database, internet searches, and searching of selected websites (see *Appendix 3*). The National Research Register and UK Clinical Research Network were also searched for ongoing research.

A master search strategy was created and modified as needed for searching across the breadth of databases; a list of terms can be found in *Appendix 3*. Modifications included changes to syntax, fields searched and Medical Subject Heading/thesaurus terms. Full search strategies are available from the first author, and example search strategies for MEDLINE, ERIC and Web of Science are provided in *Appendix 3*. Searches were limited to English-language articles only. When possible, search filters were used to limit study types returned.

Inclusion criteria

We considered inclusion criteria based on types of studies, participants and types of measurement.

Types of studies

We included:

- all relevant randomised and quasi-randomised trials of social, psychological and educational early interventions for children with a diagnosis of ASD
- observational studies of children with ASD (cross-sectional and longitudinal)
- case–control studies
- cohort studies, including studies of baby siblings of children with autism, which provide information on tools to monitor developmental progress and follow early markers of ASD.

Types of participants

We reviewed all studies that included at least 50% of children with ASD. Child participants had a 'best-estimate' clinical diagnosis of an ASD, including autism, ASD, atypical autism, Asperger syndrome and pervasive developmental disorder – not otherwise specified (PDD-NOS), according to either ICD-10 or DSM-IV[48,49] criteria. Use of a particular diagnostic tool such as the Autism Diagnostic Observation Schedule (ADOS) or the Autism Diagnostic Interview-Revised (ADI-R) was not required. Children with ASD and another medical condition, and children with ASD and comorbid conditions were included.

All children were aged ≤ 6 years upon entering the study.

Types of measurement included

- Direct assessment of child ASD symptoms by trained assessor.
- Direct assessment of developmental skills, i.e. language, cognition, play skills, fine and gross motor skills, by trained assessor.
- Observational coding of social interaction skills.
- Interview or self-completed (parent, teacher or other professional) questionnaire report of child ASD symptoms.
- Interview or self-completed questionnaire report of developmental skills, i.e. language (vocabulary), adaptive skills, with/by parent, teacher or other professional.
- Interview or self-completed (parent, teacher or other professional) questionnaire report of associated problems, including behaviour that challenges, aggression, sleeping, eating, toileting, anxiety, hyperactivity and others identified through parent consultation.
- Idiographic measures focused on particular behaviours (e.g. goal attainment scaling, target behaviours).
- Measures of impact on parent or family.

Types of measurement not included

- Economic impact on home and family.
- Experimental tasks and measures, for example barrier tasks, reaction time.
- Biophysical measures, medical investigations.
- Process measures, for example fidelity, adherence, parent satisfaction with intervention.

Sifting

Papers were first sifted by title and abstract (*Figure 2*). The decision categories were 'potentially include', 'exclude', 'consider for *Chapter 4*' (assesses the measurement properties of a tool only) or 'unclear'. The two reviewers (NL, IPO) cross-checked sets of 20 papers at a time until they reached a high level of agreement. Regular (at least weekly) discussion of decisions was held throughout the process to maintain consistency. Then 3059 papers were examined at full text. When decisions regarding inclusion were uncertain, a third reviewer (HMcC) made the final decision.

There was a further stage of sifting of records found during the search of papers about measurement properties of tools (see *Chapter 4*), with searches completed by 9 September 2013. Those searches revealed 118 records potentially relevant to *Chapter 3*. Once duplicates were removed (86), 32 additional records were sifted by full text (completed 8 December 2013): of these, 28 were excluded and four were added to the final total for data extraction.

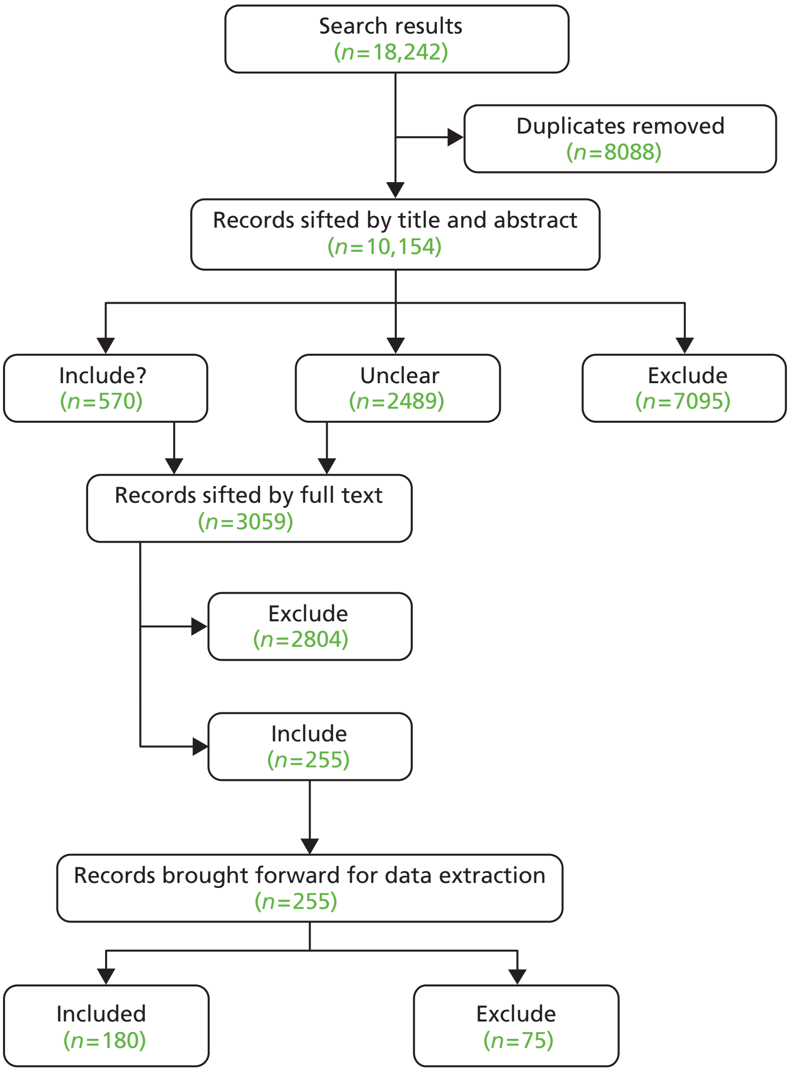


FIGURE 2 Flow diagram of searching and sifting. Search results up to date as of 17 July 2013 (original search and update combined). Sifting decisions up to date as of 13 August 2013. Final total for data extraction = 184 (with addition of records identified at stage 3).

Data extraction

A data extraction tool was created as a web-based instrument and piloted (see *Appendix 4*). The data extracted included study eligibility; type of study; participant characteristics; number of outcome tools (then for each tool: name, population for which designed, specific subscales, outcomes measured according to authors). Subsequently, two reviewers with expertise in ASD (JR, HMcC) reviewed each paper further and indicated which subdomains in the conceptual framework (see *Table 1*) were measured by each tool, including subscales.

Results

The data extracted from the 184 papers are presented in *Appendix 5*. All of the tools identified in the review as used to measure outcomes are presented in *Table 3*. In addition, there were a number of tools developed for use in particular studies; these were described as, for example, 'Caregiver–child interaction', 'Coded observation of joint attention', 'Examiner ratings of social engagement', 'Naturalistic examiner–child play sample', 'Parent interview', 'Video recording of child in classroom activities', 'Sleep diaries' and so on. Such tools could not be searched for in databases by name (see *Chapter 4*) to examine their measurement properties and so were not considered further (see *Appendix 5*). When tools had a

TABLE 3 Tools used in observational and intervention evaluation studies

Subdomains	Tools
Autism symptom severity	Autism Behavior Checklist
	Autism Diagnostic Interview-Revised
	Autism Diagnostic Observation Schedule
	Autism Observation Scale for Infants
	Baby and Infant Screen for Children with aUtIsm Traits-Part 1
	Behavioral Summarized Evaluation Scale (also Revised)
	Childhood Autism Rating Scale
	Gilliam Autism Rating Scale
	Infant Behavioral Summarized Evaluation scale
	Modified Checklist for Autism in Toddlers
	Parent Observation of Early Markers Scale
	Pervasive Developmental Disorders Behavior Inventory
	Real Life Rating Scale (Ritvo–Freeman)
	Social Communication Questionnaire (originally known as Autism Screening Questionnaire)
	Social Responsiveness Scale
	Childhood Autism Rating Scale – Tokyo version[a]
Social awareness	Communication and Symbolic Behavior Scales-Developmental Profile (Behavior Sample)
	Early Social Communication Scales
	Imitation Battery
	Imitation Disorders Evaluation scale
	Motor Imitation Scale
	Preschool Imitation and Praxis Scale
	Pre-Verbal Communication Schedule
	Social Communication Assessment for Toddlers with Autism
	Social Communication Behaviour Codes
Restricted, repetitive behaviour	Autism Diagnostic Interview-Revised
	Autism Diagnostic Observation Schedule
	Repetitive Behavior Scale (and Revised)
Sensory processing	Infant/Toddler Sensory Profile
	Sense and Self-Regulation Checklist
	Sensory Profile
	Short Sensory Profile
	Autism Screening Instrument for Educational Planning
	Battelle Developmental Inventory-Second Edition

continued

TABLE 3 Tools used in observational and intervention evaluation studies (*continued*)

Subdomains	Tools
Language	British Picture Vocabulary Scale-II
	Clinical Evaluation of Language Fundamentals-Revised
	Communication and Symbolic Behavior Scales-Developmental Profile (Caregiver Questionnaire)
	Comprehensive Assessment of Spoken Language
	Expressive One-Word Picture Vocabulary Test
	Illinois Test of Psycholinguistic Abilities
	MacArthur–Bates Communicative Developmental Inventories
	Mullen Scales of Early Learning
	Pragmatics Profile
	Preschool Language Scales
	Reynell Developmental Language Scales
	Sequenced Inventory of Communication-Revised
	Test for Auditory Comprehension of Language
	Test of Language Development
	Vineland Adaptive Behavior Scales
	Peabody Picture Vocabulary Test-Revised[a]
	Differential Ability Scales[a]
Cognitive ability	Battelle Developmental Inventory
	Bayley Scales of Infant Development
	Behavior Rating Inventory of Executive Function-Preschool Version
	British Ability Scales
	Cattell Infant Intelligence
	Developmental Profile
	Griffiths Mental Developmental Scales
	Leiter International Performance Scale-Revised
	Leiter Performance Scales (Arthur adaptation)
	McCarthy Scales of Children's Abilities
	Merrill–Palmer Scale of Mental Tests
	Mullen Scales of Early Learning
	Snijders–Oomen Non-Verbal Intelligence Test
	Stanford–Binet Intelligence Scale
	Wechsler Intelligence Scale for Children-Revised
	Wechsler Preschool and Primary Scale of Intelligence-Revised
	Differential Ability Scales[a]
	Tanaka–Binet Intelligence Test (Japanese version of Stanford–Binet)[a]
	Kyoto Scale of Psychological Development[a]
	Snabbt Performance Test På Intelligence IQ II[a]

TABLE 3 Tools used in observational and intervention evaluation studies (*continued*)

Subdomains	Tools
Attention	Behavior Assessment System for Children-Second Edition
	Child Behavior Scale
	Child Behavior Checklist
	Connors Rating Scales-Revised
Emotional regulation	Baby and Infant Screen for Children with aUtIsm Traits-Part 2
	Behavior Assessment System for Children-Second Edition
	Child Behavior Checklist
	Children's Global Assessment Scale
	Conners Rating Scales-Revised
	Developmental Behaviour Checklist
	Emotion Regulation Checklist
	Infant–Toddler Social–Emotional Assessment
	Toddler Behavior Assessment Questionnaire
Physical skills	Annett's Pegs
	Beery Visual–Motor Integration Test
	Brunet–Lezine's Oculomotor Coordination Subtest
	Functional Independence Measure for Children
	Infant Motor Maturity and Atypicality Coding Scales
	Mullen Scales of Early Learning
	Peabody Developmental Motor Scales
	Vineland Adaptive Behavior Scales
Physical indicators	–
Social communication	Autism Diagnostic Interview-Revised
	Autism Diagnostic Observation Schedule
	Autism Screening Instrument for Educational Planning
	Communication and Symbolic Behavior Scales-Developmental Profile (Caregiver questionnaire)
	Early Social Communication Scales
	Pragmatic Profile
	Social Communication Assessment for Toddlers with Autism
	Social Communication Behavior Codes
Social functioning	Autism Diagnostic Interview-Revised
	Child Behavior Scale
	Nisonger Child Behavior Rating Scales
	Social Behavior Rating Scale
	Vineland Adaptive Behavior Scales
	Vineland Social Maturity Scale, Indian adaptation[a]

continued

TABLE 3 Tools used in observational and intervention evaluation studies (*continued*)

Subdomains	Tools
Play	Communication and Symbolic Behavior Scales-Developmental Profile (Caregiver Questionnaire)
	Developmental Play Assessment
	Structured Play Assessment
	Symbolic Play Test
	Test of Pretend Play
	Preschool Play Scale[a]
Behaviour problems	Aberrant Behavior Checklist
	Baby and Infant Screen for Children with aUtIsm Traits-Part 3
	Behavior Assessment System for Children-Second Edition
	Behavior Screening Questionnaire
	Child Behavior Checklist
	Child Behavior Scale
	Conners Rating Scales-Revised
	Developmental Behaviour Checklist
	Home Situations Questionnaire-Pervasive Developmental Disorders version
	Nisonger Child Behavior Rating Scales
	Parent Target Problems (or Parent Target Behaviours)
	Preschool Behaviour Checklist
	Behavior Style Questionnaire – Chinese version[a]
Habit problems	Child Behavior Checklist
	Sense and Self-Regulation Checklist
Learning	Autism Screening Instrument for Educational Planning
	Extended Basic Academic Skills Assessment System
	Wechsler Individualised Achievement Test
Daily living skills	Functional Independence Measure for Children (WeeFIM)
	Vineland Adaptive Behavior Scales
Global measure of function	Ages and Stages Questionnaire
	Assessment of Basic Language and Learning Skills
	Assessment, Evaluation and Programming System
	Behavior Assessment System for Children-Second Edition
	Brigance Diagnostic Inventory of Early Development-2 developmental profile
	Early Intervention Developmental Profile
	Early Learning Accomplishment Profile
	Functional and Emotional Developmental Questionnaire
	Learning Accomplishment Profile-Diagnostic, Third Edition
	Pediatric Daily Occupation Scale
	Preschool Developmental Profile
	Psychoeducational Profile-Revised

TABLE 3 Tools used in observational and intervention evaluation studies (*continued*)

Subdomains	Tools
	Scales of Independent Behavior-Revised, Early Development Form
	Vineland Adaptive Behavior Scales
	Social Adaptive Development Quotient Scale[a]
Global measure of outcome	Autism Treatment Evaluation Checklist
	Behavioral Summarized Evaluation scale (and Revision)
	Clinical Global Impression – Improvement Scale
	Infant Behavioral Summarized Evaluation scale
	Pervasive Developmental Disorders Behavior Inventory
Social relations	–
Subjective well-being	Kiddie–Infant Descriptive Instrument for Emotional States[a]
Social inclusion	School Liking and Avoidance Questionnaire
	Teacher Rating Scale of School Adjustment
Interaction style	Functional Emotional Assessment Scale
	NICHD Early Child Care Network scales
Parent stress	Autism Parenting Stress Index
	Beck Anxiety Inventory
	Center for Epidemiologic Studies Depression Inventory
	General Health Questionnaire
	Hospital Anxiety and Depression Scale
	Parenting Sense of Competence
	Parenting Stress Index
	Positive and Negative Affect Schedule
	Questionnaire on Resources and Stress-Friedrich Short form
	Reaction to Diagnosis Interview
	Satisfaction with Life Scale
	Stress Arousal Checklist
	Symptom Checklist-90-Revised
Family quality of life	Beach Family Quality of Life Questionnaire
	Family Adaptability and Cohesion Evaluation Scales II
	Family Assessment Device-General Functioning Scale
	Family Assessment Measure
	Family Empowerment Scale
	Family Support Scale
	Kansas Inventory of Parental Perceptions
	McMaster Family Assessment Device
	Parenting Alliance Inventory

NICHD, National Institute of Child Health and Human Development (USA).
a Exclude: used only pre-1995; version for a non-UK country.

generic-sounding name, information from the source reference was included in the searching. Other tools included below, but not considered further, were:

- adaptations of tools for use in another language, or tools for which an alternative UK version exists
- tools used only in outcome and monitoring studies published before 1995 (given different diagnostic definitions before 1994).

Conclusion

There were 131 tools to be taken forward, and their names (and acronyms) were used in searches to find papers on their measurement properties (described in *Chapter 4*). It is apparent that, as discussed in the introduction to this chapter, the tools used in research studies to measure outcomes include many which were designed for a different purpose, such as for screening or to enable conclusions to be drawn about an ASD diagnosis in children. However, the review has adopted a pragmatic, inclusive approach to the examination of the identified tools.

The planned data extraction in this chapter was to have included information about the reliability, validity and responsiveness to change of tools as described in the intervention evaluation and observational studies. However, when this extraction was piloted, it was found that most studies simply cited the reliability and validity of tools from their source references, irrespective of whether this had been tested with samples of children with ASD. Furthermore, it was not possible to interpret the evidence on responsiveness to change without considering whether the study was adequately powered to detect change, and whether the choice of outcome tool was appropriate to the nature of the intervention. If a significant intervention effect was not shown, there were a number of possible reasons, and the properties of the tool constituted only one of those reasons. For these reasons, the decision was taken to rely on the systematic assessment of measurement properties of tools described in *Chapter 4*.

Chapter 4 Systematic review of measurement properties of tools

Introduction

The searches reported in *Chapter 3* revealed the varied range of tools used in the 184 papers from which data were extracted. The next stage of the MeASURe project examined the measurement properties of these tools. As an introduction, we summarise the many different types of tools currently in use, involving face-to-face assessment, observation or report.

Types of measurement in use

Standardised norm-referenced assessments all have to be administered by a trained professional. They have the advantage of comparison with children of the same age but for several reasons may be misleading when used for the assessment of young children with ASD. The abilities of the children may be underestimated by lack of co-operation with standardised testing, and they may have profiles that are dissimilar to typical development.

Direct observation includes both highly structured observational procedures (such as ADOS)[50] and tools used primarily to measure social interaction in naturalistic settings, especially parent–child interaction. The former are a diagnostic assessment tool conducted by a trained assessor with subsequent rating of the child's behaviours. The latter have the advantage of providing an in-depth understanding of patterns of responsiveness, which may have long-term effects on language and other development.[51,52] However, one major disadvantage of direct observation is the limited time frame with consequent questions of validity. Further, there are almost as many different coding schedules as studies, depending on the focus of interest.

Standardised semistructured interviews have been used in the characterisation of children's early development and current ASD characteristics (e.g. the ADI-R),[53] in the broad measurement of adaptive behaviour [e.g. Vineland Adaptive Behavior Scales (VABS)][54] and to gather information on additional difficulties, such as behaviour problems, anxiety and sleep. Problems of measurement include a paucity of tools focused on behaviour, which are specifically validated for ASD (e.g. the Autism Comorbidity Interview-Present and Lifetime Version is one such tool but is validated from only 5 years of age).[55]

There are very many questionnaires used in studies of children with ASD, completed by parents, teachers and clinicians. However, as with the direct observation and assessment tools, many have not been specifically validated for use in ASD and contain assumptions about patterns of typical development (e.g. standard quality-of-life measures do not ask about children's special skills and circumscribed interests).

Search strategies

Not all tools identified in *Chapter 3* could be searched for by name. There were two main reasons. First, a number of tools had been developed for a particular study (such as a coding procedure for playground behaviour or parent–child interaction, with content related to a particular intervention approach). Second, some tools were translations or adaptations of tools for use in another country, or had been used only up to 1994. Thus papers relating to 131 tools could be searched for by name. Because of its particular relevance to the review, it was decided to add the Early Years Foundation Stage Profile, identified in our consultation with professionals in *Chapter 2* as being widely used in nurseries.

Original searches for stage 3 were conducted in March and April 2013, with iterative searches run in August, September and November 2013. The databases searched were:

- ERIC (ProQuest): 1966 to present
- MEDLINE (Ovid): 1946 to present
- EMBASE (Ovid): 1988 to present
- CINAHL (EBSCO*host*): 1981 to present
- PsycINFO (Ovid): 1987 to present.

In order to search for papers describing studies of the measurement properties of tools, a search filter developed by the COnsensus-based Standards for the selection of health status Measurement INstruments (COSMIN) group was applied.[56] The COSMIN filter was originally designed for use in PubMed, and was translated for use in other databases by our information specialist (SR). The translation was tested in Ovid, and discrepancies were discussed with CBT (co-investigator, and part of the team who devised COSMIN). The sensitivity of the revised filters was tested continuously through the early part of data extraction, through inspection of references for 'marker' papers that should have been included, until the new filters were judged satisfactory. The translation can be found in *Appendix 6*.

Each search consisted of four components: autism terms, age group terms, COSMIN filter and tool name. A master search strategy was created and modified as needed for searching in various databases – a list of terms can be found in *Appendix 6*. Tool names required basic searches in their own right to determine variant spellings, variant names and to include acronyms. For example, numerous tools include the word 'scale', but this might have been reported as 'scales', 'scale', 'score' or 'scores' by the authors. Some databases, notably PsycInfo, include a field for tests and measures, and this was utilised if available, as this provides a standard way of identifying a tool regardless of how an author has reported the title.

Searches were limited to English-language papers only and papers published from 1992 to present. Measurement tool-only search strategies are available in *Appendix 6*.

Finally, the searches in *Chapter 3* had identified 128 papers which were about measurement properties of tools rather than about monitoring progress or outcomes, and so these were also included in the stage 3 sifting (see *Figure 3*).

Inclusion criteria

1. Study was published as a 'full text original article'.
2. The tool measured a domain of interest (see 'conceptual framework', *Table 1*).
3. A tool identified at stage 2 (i.e. used for monitoring and/or to measure outcome in a longitudinal or intervention study with children with ASD up to 6 years old) was the focus of the study. (When a paper reported the measurement properties of a 'new' relevant tool this was noted but not included.)
4. The study sample overlapped with the age range 0–6 years (e.g. a sample with age range from 6 to 18 years was judged eligible; one that included 8- to 15-year-olds was ineligible).
5. The study sample included at least 50% of children with ASD. Furthermore, the study sample could be individuals who were being monitored for ASD symptoms even if they had another primary diagnosis (e.g. a paper monitoring ASD symptoms in a Fragile X population could be eligible if exploring measurement properties of a tool used as an outcome).
6. The aim of the study was the development of a measurement tool or the evaluation of one or more of its measurement properties. Note: The property 'Hypothesis testing' applies in COSMIN to hypothesis testing within a paper about construct validity of a tool (e.g. convergent/divergent validity against other tools; known-groups validity). Studies that tested research hypotheses about change or differences between groups as the result of an intervention, but did not set out to test the measurement properties of the tool, were excluded.

Exclusion criteria

1. Papers in which the measurement tool was tested only for its properties in diagnostic assessment or screening and not for monitoring or measuring an outcome.
2. A sample drawn only from the general population of children.
3. Sample size of < 20.
4. Studies in which the focus of the paper was not the examination of psychometric properties were not eligible (e.g. if the paper focused only on creating a subtype of ASD, or to group individuals by scores on the tool).
5. With regard to papers on translated tools, if the purpose was simply to validate the translated version then it was not eligible. If the purpose was to explore the tool's validity in a different culture/country, and the focus was on the properties of the tool, and the findings appear relevant for use in UK then it was included.

Four reviewers (MG, JH, NL, IPO) utilised the criteria to sift 10% of articles (*Figure 3*) independently and to compare results, resulting in tightening of criteria. Sifting was then conducted by a single reviewer, the team having (at random) divided up assessment of titles and abstracts, selection of full-text articles and consultation of reference lists of the studies retrieved. In case of uncertainty, the paper was discussed with HMcC before making the decision regarding inclusion. As the COSMIN rating procedure (see below) involves two stages, and the second summary stage involved a different member of the team (including HMcC) in rating the content of each article, some further exclusions were made, so that the decision-making procedure was very robust.

Evaluation of methodological quality

The methodological quality of the studies of measurement properties identified was then assessed using the COSMIN checklist.[57] The checklist has 10 'boxes' or subscales (Internal consistency; Reliability; Measurement error; Content validity; Structural validity; Hypotheses testing; Crosscultural validity; Criterion validity; Responsiveness; Interpretability) with standards for how each measurement property should be assessed (see *Appendix 7*). Each item is scored on a four-point rating scale (poor to excellent) and an overall rating for the methodological quality of each study is determined. The full tables are presented in *Appendix 8*.

At the same time, each reviewer extracted relevant numerical and descriptive information about the properties addressed (available from the first author). Terwee *et al.*[57] presented criteria for judging the adequacy of each piece of information (*Table 4*).

The final step was to combine the ratings of quality of the studies with the ratings of strength of the findings (*Table 5*) in order to make judgements related to each measurement tool.

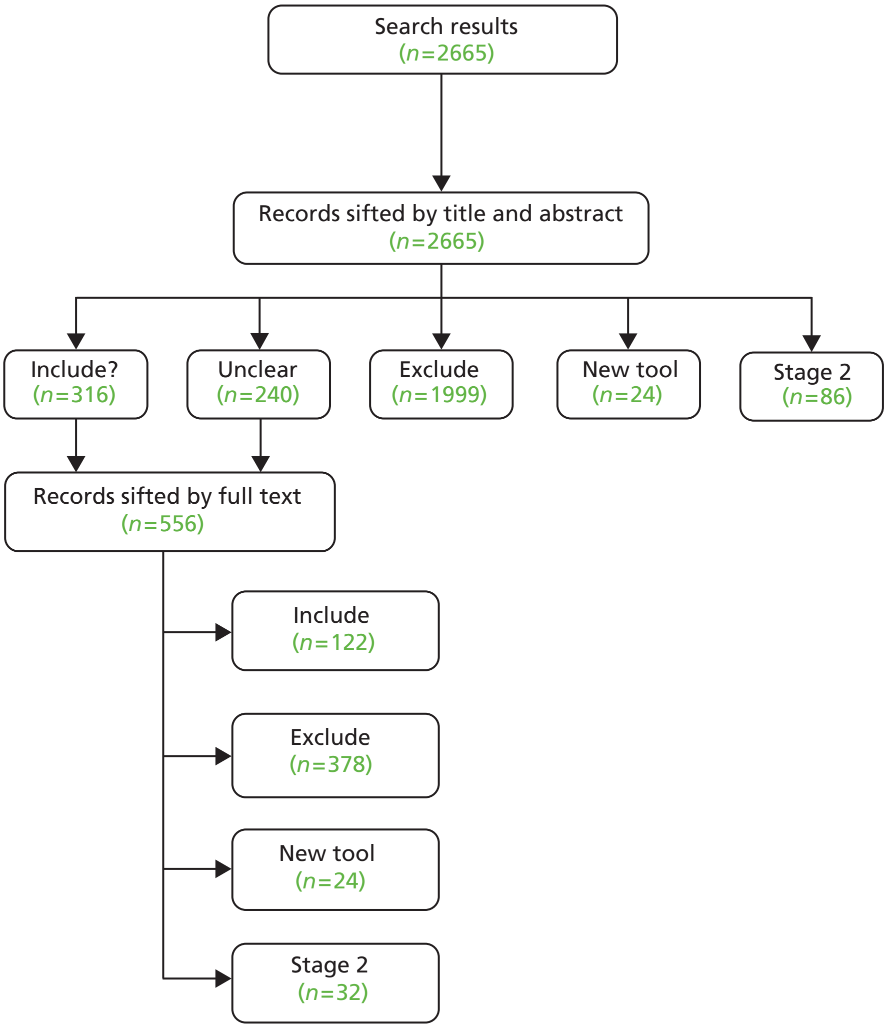


FIGURE 3 Flow diagram of searching and sifting. Original stage 3 search results up to date as of 9 September 2013. Sifting decisions up to date as of 24 February 2014. Final total for data extraction = 128 (with addition of records identified at stage 2).

TABLE 4 Quality criteria for good measurement properties[a]

Property	Rating	Quality criteria
Reliability		
Internal consistency	+	Cronbach's alpha(s) ≥ 0.70
	?	Cronbach's alpha not determined or dimensionality unknown
	–	Cronbach's alpha(s) < 0.70
Reliability	+	ICC/weighted kappa ≥ 0.70 *or* Pearson's *r* ≥ 0.80
	?	Neither ICC/weighted kappa, nor Pearson's *r* determined
	–	ICC/weighted kappa < 0.70 *or* Pearson's *r* < 0.80
Measurement error	+	MIC > SDC OR MIC outside the LOA
	?	MIC not defined
	–	MIC ≤ SDC OR MIC equals or inside LOA
Validity		
Content validity	+	All items are considered to be relevant for the construct to be measured, for the target population, and for the purpose of the measurement *and* the questionnaire is considered to be comprehensive
	?	Not enough information available
	–	Not all items are considered to be relevant for the construct to be measured, for the target population, and for the purpose of the measurement *or* the questionnaire is considered not to be comprehensive
Construct validity – structural validity	+	EFA: Factors should explain at least 50% of the variance; CFA: RMSEA ≤ 0.06, CFI or TLI ≥ 0.95
	?	Explained variance not mentioned
	–	EFA: Factors explain < 50% of the variance; CFA: RMSEA > 0.06, CFI or TLI < 0.95
Hypothesis testing	+	Correlations with instruments measuring the same construct ≥ 0.50 *or* at least 75% of the results are in accordance with the hypotheses *and* correlations with related constructs are higher than with unrelated constructs
	?	Solely correlations determined with unrelated constructs
	–	Correlations with instruments measuring the same construct < 0.50 *or* < 75% of the results are in accordance with the hypotheses *or* correlations with related constructs are lower than with unrelated constructs
Criterion validity	+	Convincing arguments that gold standard is 'gold' *and* correlation with gold standard ≥ 0.70
	?	No convincing arguments that gold standard is 'gold' *or* doubtful design or method
	–	Correlation with gold standard < 0.70, despite adequate design and method
Responsiveness		
Responsiveness	+	Correlation with changes on instruments measuring the same construct ≥ 0.50 *or* at least 75% of the results are in accordance with the hypotheses *or* AUC ≥ 0.70 *and* correlations with changes in related constructs are higher than with unrelated constructs
	?	Solely correlations determined with unrelated constructs
	–	Correlations with changes on instruments measuring the same construct < 0.50 *or* < 75% of the results are in accordance with the hypotheses *or* AUC < 0.70 *or* correlations with changes in related constructs are lower than with unrelated constructs

AUC, area under the curve; CFA, confirmatory factor analysis; CFI, comparative fit index; EFA, exploratory factor analysis; ICC, intraclass correlation coefficient; LOA, limits of agreement; MIC, minimal important change; RMSEA, root–mean–square error of approximation; SDC, smallest detectable change; TLI, Tucker–Lewis fit index.
a COSMIN website: www.cosmin.nl.
Rating: +, positive; ?, indeterminate; –, negative.

TABLE 5 Levels of evidence (COSMIN)[a]

Level	Rating	Criteria
Strong	+++ or – – –	Consistent findings in multiple studies of good methodological quality *or* in one study of excellent methodological quality
Moderate	++ or – –	Consistent findings in multiple studies of fair methodological quality *or* in one study of good methodological quality
Limited	+ or –	One study of fair methodological quality
Conflicting	+/–	Conflicting findings
Unknown	?	Only studies of poor methodological quality

a COSMIN website: www.cosmin.nl.
Rating: +, positive; ?, indeterminate; –, negative.

Findings

Of the 132 tools searched by name, no papers meeting inclusion criteria were found for 75 tools, and therefore their measurement properties in use with children with ASD could not be examined further (see *Appendix 8* for all tool names within subdomains). Thus the tables and summaries of findings refer to the remaining 57 tools (43%) for which evidence was obtained.

The presentation of findings is organised in terms of the subdomains of the conceptual framework for the review (see *Table 1*). For clarity, the first section includes tools that measure symptom severity in ASD, and then global measures of outcome (given extensive overlap between the two). Where the measurement properties of subscales of tools have been evaluated, the tools appear in several separate subdomain tables. In the tables, shaded rows indicate tools for which only poor or negative evidence was obtained. In several cases, the versions of the tools that have been evaluated in the studies have been superseded; the newer versions are referred to in *Chapter 5*.

The subdomains for which no tool-related evidence was found include Learning; Social relations; Subjective well-being; Social inclusion; Parent–child interaction style; Parenting; and Family quality of life. No tools for physical indicators (tics, gut/bowel symptoms, nutritional status) were included in searches. The gaps in evidence will be discussed further in *Chapter 5*.

Autism symptom severity

For details, see *Table 6*.

Autism Behavior Checklist

The Autism Behavior Checklist (AuBC)[58,59] was originally constructed as a screening questionnaire completed by parents/carers. It has 57 items grouped into five subscales: Sensory; Relating; Body and object use; Language; and Social and self-help skills, and provides different profile charts for different age groups, ranging from 18 months to 35 years. Three papers[60–62] considering measurement properties of the AuBC since 1992 were reviewed, of which two[60,61] had very small samples. Miranda-Linné *et al.*[62] used AuBC with parents of 383 individuals aged 5–22 years. Using factor analysis, they found a five-factor solution that was inconsistent with the five factors suggested by the originators, explaining 80% of the variance but with good internal consistency of subscales.

TABLE 6 Summary of quality: autism symptom severity

Tool (number of papers)	Internal consistency	Reliability: Test–retest	Reliability: Inter-rater	Content validity	Structural validity	Hypothesis testing: Convergent/divergent validity	Hypothesis testing: Known groups	Criterion validity	Responsiveness: Stability	Responsiveness: Change
Autism Behavior Checklist (3)	++		?		+					
Autism Diagnostic Interview-Revised (12)	+++		++	+++	+/–	– –	++	++	++	
Autism Diagnostic Observation Schedule (7)	?	?	+	+	+++			++	++	
Autism Diagnostic Observation Schedule-Toddler Module (1)	+/–	+/–	?	+						
Autism Diagnostic Observation Schedule-Calibrated Severity Score (3)							+++		+	
Autism Observation Scale for Infants (2)		?	?				++			
Baby and Infant Screen for Children with aUtIsm Traits-Part 1 (3)	++				– –	++	++			
Behavioral Summarized Evaluation (1990) and Behavioral Summarized Evaluation-Revised (1997) (4)	?		+	+++	+/–	+	+	?		
Infant Behavioral Summarized Evaluation (1)			+		?					
Childhood Autism Rating Scale (10)	+++	+++	+++		+/–	– –				
Gilliam Autism Rating Scale (3)	+++		– –		– – –		–			
Modified Checklist for Autism in Toddlers (3)	?	?	?					+		
Parent Observation of Early Markers Scale (1)	++	?				–				
Pervasive Developmental Disorders Rating Scale (2)	++	+			?					
Real Life Rating Scale (2)	?		?							
Social Communication Questionnaire (3)	++				++			++	+	
Social Responsiveness Scale (5)	+++	+/–	+/–		– – –	++	+	– –		

+++ or – – –, strong evidence; ++ or – –, moderate evidence; + or –, limited evidence; ?, unknown, owing to poor methodological quality; blank cell, no evidence available.

Autism Diagnostic Interview-Revised

The ADI-R[53,63] is a standardised semistructured investigator-based interview, which is administered by a trained clinician usually to parents/caregivers. The 1994 revision had 111 items and the 2003 published version has 93 items. Papers on measurement properties have utilised varying numbers of items; for example, Lecavalier *et al.*[64] considered only the algorithm items that are used in determining diagnosis. The ADI-R has good internal consistency, although the Repetitive Behaviours domain consistently shows Cronbach's alpha coefficient to be < 0.7 in the papers examined. Several studies report that inter-rater reliability was monitored and kept at 90% agreement. Studies that formally tested inter-rater reliability reported good levels; for example, Lord *et al.*[65] reported kappa statistics of between 0.6 and 0.8 on individual items and 92% agreement on diagnostic cut-off.

Extensive work has been done on content validity of the ADI-R as a 'gold standard' diagnostic tool. One paper[66] used principal components analysis to derive six clusters, but noted that the inclusion of a few specific items on to particular clusters was unexpected. The evidence concerning structural validity was somewhat contradictory; because of the large numbers of items, few papers included sufficient participants, even for reduced-item sets. The confirmatory factor analyses for two- or three-factor solutions were 'reasonable' [i.e. root–mean–square error of approximation (RMSEA) of ≤ 0.07],[64,67,68] i.e. just above cut-off for a rating of 'good fit'. Frazier *et al.*[67] indicated that factor structures fit equally well for 2- to 6-year-olds as for those aged ≥ 7 years. Other than testing level of agreement with ADOS (see *Autism Diagnostic Observation Schedule*, below), only one study[64] explicitly addressed convergent/divergent validity, finding that the ADI-R Social domain correlated with all VABS (–0.41 to –0.45) except for motor skills. A strong indication of validity at the level of individual ADI-R items in distinguishing between children with ASD and those without (mostly non-referred) was provided by Tsuchiya *et al.*[69] Criterion validity was examined in the original Lord *et al.*[63] paper. In addition, Chawarska *et al.*[70] examined whether infants referred at age 14–25 months (and diagnosed 15 months later) could be classified at first assessment; 48% who later received the diagnosis of autism were classified as such, but 78% if the ADI Repetitive behaviours scale was dropped.

As a diagnostic tool, ADI-R might not be expected to be responsive to change; indeed, measurement properties papers[65,71] do find general stability in meeting diagnostic cut-off after 6–8 years in each of the domains. However, Lord *et al.*[65] reported that classifications changed substantially more often from ages 2 to 5 years than from ages 5 to 9 years.

Autism Diagnostic Observation Schedule-Generic

The Autism Diagnostic Observation Schedule-Generic (ADOS-G)[50] is a semistructured, interactive schedule designed to assess aspects of communication, social reciprocal interaction, play, and stereotyped behaviours and restricted interests. The ADOS-G consists of four modules, appropriate for children and adults of differing language levels, ranging from non-verbal to verbally fluent. The most able, verbally fluent, children may be assessed with module 3; less able children with modules 1 or 2. The social communication algorithm score is reported as the 'total', as repetitive behaviours may not be observed within a limited-duration play-based assessment.

Seven papers[50,65,70,72–75] considering measurement properties of the ADOS-G were reviewed. The original study[50] assessed internal consistency. For the social communication totals, Cronbach's alpha coefficients were high (0.91–0.94) for modules 1–3; however, as the sample size included in each of the unidimensionality analyses was small, the study was judged poor. Three studies[50,65,72] assessed inter-rater reliability. Two of these studies[65,72] found kappa statistics to range from 0.60 and 0.80 on all items, and Lord *et al.*[65] found 92% agreement for autism/not autism. However, the lack of methodological information regarding these analyses led the study by Kamp-Becker *et al.*[72] to be judged as of poor methodological quality. Lord *et al.*[50] presented inter-rater kappa statistics for each module separately and found a mean weighted kappa statistic of 0.78 for module 1, 0.70 for module 2 and 0.65 for module 3. For the social-communication algorithm total, test–retest intraclass correlations (ICCs) ranged from 0.84 to 0.98. However, the small sample size for all reliability calculations within modules (ranging from $n = 23$ to $n = 29$) led this paper to be judged as of poor methodological quality.

Three papers[50,72,73] assessed structural validity. Lord *et al.*[50] found almost all social and communication items loaded highly on one factor in each module, accounting for between 72% and 78% (modules 1 and 2), and 52% and 53% (modules 3 and 4) of the variance, leading to the adoption of an algorithm total of social-communication items. However, the small sample size (79 participants and 29 ratings in module 1, 55 children and 28 ratings in module 2, and 59 participants and 28 ratings in module 3) led this study to be judged to be of poor methodological quality. Kamp-Becker *et al.*[72] assessed structural validity and found in a three-factor solution the amount of variance explained was 47%, in the four-factor solution it was 52% and the five-factor solution explained 57% of variance. The third paper[73] investigated both the original algorithm structure and the new algorithms, compatible with DSM-5. For the youngest group ($\leq$ 6 years) they found RMSEAs of 0.057 and 0.059, respectively, for module 1 (indicating good model fit) and RMSEAs of 0.079 and 0.076, respectively, for module 3 (indicating reasonable model fit).

Two studies assessed criterion validity. Grey *et al.*[74] found high agreement between ADOS and a clinical diagnosis of autism [kappa (κ) = 0.73; $p < 0.001$] and of ASD ($\kappa = 0.62$; $p < 0.001$) in 209 children aged 20–55 months (120 with autism or ASD). In a study of infants aged 14–25 months, Chawarska *et al.*[70] found between 79% and 95% agreement between the ADOS-G module 1 diagnostic classification outcomes and clinician-assigned diagnosis of autism, although agreement with an ASD diagnosis was low. They comment that in this infant sample the ADOS tended to under-diagnose children with higher verbal and non-verbal skills.

This tool had three papers[65,70,75] assessing ‘responsiveness’, or rather testing a hypothesis of stability. The first paper[65] found that regression prediction of each ADOS domain score at age 9 years, by the set of three domain scores at age 2 years, showed significant continuity within the same domain (with one exception – the communication score at age 9 years – which was predicted by the ADOS Social and Repetitive domains at age 2 years, with no significant independent contribution from communication). Chawarska *et al.*[70] tested stability at 15 months from first assessment and found no significant diagnosis by time interactions. Ben Itzchak and Zachor[75] also reported stability for 78% of their sample of 68 children, mean age 26 months, in terms of ADOS classification over 1 year; however, the lack of specific hypotheses led this paper to be judged as being of poor methodological quality.

Autism Diagnostic Observation Schedule-Toddler Module

The need for a tool that could assess children for autism at an earlier age led to development of the Autism Diagnostic Observation Schedule-Toddler Module (ADOS-T). The development paper[76] involved 182 children with best estimate diagnoses of ASD, non-spectrum developmental delay or typical development, aged 12–30 months. Content validity was good; items were revised, rewritten or removed, as necessary, until all remaining items were deemed relevant. Two algorithms were developed: one for toddlers who were verbal and aged 21–30 months, and the other for younger, less-able toddlers. Internal consistency was good for the social affect scale for both groupings, and poor for RRBs. Test–retest reliability was not high (ICC = 0.6) for RRBs for the verbal toddler algorithm (and $n = 8$), but otherwise good (0.83–0.94). Inter-rater reliability was high, but the paper was judged to be of poor quality for this property, as the report was for the agreement of seven raters and 14 videos of assessment.

Autism Diagnostic Observation Schedule-Calibrated Severity Score

Refinement of the ADOS algorithm scores led on to the development of the ADOS-Calibrated Severity Score (ADOS-CSS).[77] The ADOS-CSS potentially allows for greater understanding of the manifestation of core autism symptom severity over time, independently of factors such as age, IQ and language level. Gotham *et al.*[77] tested the hypothesis that severity scores would be less related to factors such as IQ than the raw scores, and this was found. Two studies[78,79] have examined the ADOS-CSS in independent samples, with somewhat mixed findings. De Bildt *et al.*[78] found in a large clinical Dutch sample that CSS discriminated the autism, non-autism ASD and non-spectrum classifications well, and were more comparable over various developmental groupings than the raw scores on the ADOS, especially in module 1 and somewhat less so in module 3. For module 2, the larger proportion of children with non-autism ASD relative to the Gotham sample probably contributed to differences in findings. Shumway *et al.*[79] examined whether or not calibrated severity scores were independent of other factors. They found that a regression model accounted for 56% of the variance in ADOS raw score, but for only 18% of the variance in calibrated severity score, i.e. independent of verbal and non-verbal developmental quotient. In addition, they found good stability of scoring after an interval of 12–24 months.

Autism Observation Scale for Infants

The Autism Observation Scale for Infants (AOSI)[80] was developed to detect and monitor early signs of autism as they emerge in high-risk infants. It is an 18-item direct observational measure designed to detect and monitor putative signs of autism in infants aged 6–18 months. Data on inter-rater reliability was good, test–retest reliability less so, but the sample size was only 20[81] and thus judged to be of poor methodological quality. Georgiades *et al.*[82] found good discrimination between high- and low-risk infants (i.e. infant siblings of children with ASD vs. no ASD).

Baby and Infant Screen for Children with aUtIsm Traits-Part 1

The Baby and Infant Screen for Children with aUtIsm Traits-Part 1 (BISCUIT-Part 1[83]) is designed to assess symptoms of ASD in children between the ages of 17 and 37 months. It comprises 62 items scored on a three-point, Likert-type scale. Parents are asked to rate the child on each item, comparing them to a typically developing child as ‘0’ (not different; no impairment), ‘1’ (somewhat different; mild impairment) or ‘2’ (very different; severe impairment). For the factor analysis study,[84] 405 infants with a diagnosis of ASD were selected from a total of 1287 enrolled in a US state-funded early intervention programme for children at risk for a developmental disability. In factor analysis, a three-factor structure (socialisation, repetitive behaviour, communication) accounted for only 33% of the variance (with seven items that did not load on to any factor) but the internal consistency of the factors was good [alpha (α) = 0.93, 0.90, 0.87, respectively]. Factor scores were significantly higher than for infants without ASD. Matson *et al.*[85] demonstrated convergent validity of the BISCUIT-Part 1 with the Modified Checklist for Autism in Toddlers (M-CHAT) and the Personal–Social domain of the Battelle Developmental Inventory-Second Edition, and divergent validity with the Battelle Adaptive and Motor domains.

Behavioral Summarized Evaluation and Behavioral Summarized Evaluation-Revised

The Behavioral Summarized Evaluation (BSE)[86] is a 20-item instrument that examines the scope and severity of behaviour problems in autistic children. Items are rated by a clinician on a five-point scale ranging from 0 (never) to 4 (continuously). A global score can be obtained by summing the 20-item scores. A revised version later added nine items.[87] Four papers considering measurement properties of the BSE were reviewed. One study[88] assessed internal consistency and found that Cronbach’s alpha coefficients ranged from 0.83 to 0.90. However, the small sample size included in the unidimensionality analysis led this study to be judged as methodologically poor (20 items, 53 participants). Two studies assessed inter-rater reliability[86,87] and found ICCs for the global score to range from 0.96 to 0.97. However, the small sample size ($n = 29$) led one of these studies[87] to be judged as having poor methodological quality. The content validity was good, having been developed over several iterations in practice, with correlation of the global score or first factor with IQ and not with age.[86,87] Four studies[86–88,89] assessed structural validity; however, the small sample size of two studies[86,88] led them both to be judged as having poor methodological quality. Construct validity in the remaining studies was not strong overall; two main factors were found together accounting for almost 50% of the variance,[86–88] with the first factor, labelled ‘autism’ or ‘interaction disorder’, relatively consistent, but the second factor very variable. Roux *et al.*[89] further examined the structure of the first factor and found it to account for 61% of the variance. One study[88] assessed convergent validity, and found correlations between this tool and the Childhood Autism Rating Scale (CARS) to all be > 0.77. One study assessed known-groups validity[87] and found all relevant hypotheses supported. This same study assessed criterion validity[87] and found partial correlations between this tool and an expert clinical rating to range from 0.24 to 0.63 but the quality of the evidence was judged to be poor.

Infant Behavioral Summarized Evaluation

The Infant Behavioral Summarized Evaluation (IBSE) is an observational rating scale adapted from the BSE for the assessment of behaviours of young children having autistic disorders. The original paper[90] describing the development and measurement properties of the IBSE was reviewed. Eighty-nine children aged 6–48 months, referred for clinical assessment, were included. The study assessed inter-rater reliability of the initial 33 items and found an ICC of 0.97. The same study assessed the tool's structural validity: 59.4% of total variance was explained by a two-factor solution, with 19 items constituting the first factor labelled 'autism'. However, the small sample size (89 participants and 31 reliable items) led this paper to be judged as having poor methodological quality.

Childhood Autism Rating Scale

The CARS[91,92] is a behavioural rating scale that is widely used in the diagnosis of children with autism and pervasive developmental disorders. The CARS is a 15-item observation and parent interview measure that quantifies the severity of behaviours associated with autism. Items are rated on a scale from 1 ('normal') to 4 ('severely abnormal'). Total scores ≥ 30 strongly suggest the presence of autism. In a range of small studies (see *Appendix 8*), internal consistency of the total score was found to be good, as it was in one large study in India.[93] However, Magyar *et al.*[94] conducted principal components analysis, finding four factors with only one alpha coefficient of > 0.70: social communication (0.78), social interaction (0.61), stereotypies and sensory abnormalities (0.54), and emotional regulation (0.59). At the item level, average inter-rater reliability was $r = 0.71$, range for the items 0.55–0.93 (only one was > 0.80).[91] However, for the total score, inter-rater reliability was reported to be good: ICC = 0.74;[93] ICC = 0.73.[95] Test–retest reliability after 1 year, in children referred for ASD assessment, was high (ICC = 0.81).[93] A number of different factor solutions have been proposed. Stella *et al.*[96] reported five factors accounting for 64% of the variance: emotional reactivity, social communication, social orienting, odd sensory exploration, and cognitive and behavioural consistency. The four-factor structure reported by Magyar *et al.*[94] accounted for only 41% of the variance. Stella *et al.*[96] examined convergent and divergent validity of the factor scores in relation to the VABS but did not find the hypothesised pattern of correlations.

Gilliam Autism Rating Scale and Gilliam Autism Rating Scale-Second Edition

The Gilliam Autism Rating Scale (GARS) is a behavioural checklist developed for use by parents, teachers and professionals to discriminate individuals who are autistic from those with other developmental disabilities. It is intended for use with individuals aged from 3 to 22 years. The GARS has 56 items, divided into four scales; Social interaction, Communication, and Stereotyped behaviours are rated on a four-point scale of frequency, and Developmental disturbances rates early milestones on a dichotomous scale. The summary score is the Autism Quotient. South *et al.*[97] raised concerns about the capacity of the scale to detect autism in a sample of 119 children aged 3–10 years with strictly defined autism, finding that the mean Autism Quotient was significantly lower than the reference of 100. Lecavalier[98] raised similar concerns with a broader sample aged 3–21 years. Furthermore the exploratory factor analysis (EFA) of the first three scales accounted for only 37% of the variance. Internal consistency of those three scales was good; the Developmental disturbances scale was lower, with Cronbach's $\alpha = 0.68$. However, parent–teacher inter-rater reliability was low (ICC average = 0.40). Pandolfi *et al.*[99] examined the GARS-Second Edition (GARS-2), a revision and normative update,[100] which has very similar content in the main three scales. The EFA accounted for 34.1% of the variance and the factor model was not entirely consistent with the conceptually derived organisation of the GARS-2. A four-factor model was preferred, for which scale reliability estimates were good.

Modified Checklist for Autism in Toddlers

The M-CHAT was designed as a screening tool with 23 'yes/no' items that can be given to parents by clinicians, with a focus on 18–24 months of age. It does not rely on the professional's observation of the child, but on parents' report of current skills and behaviours. In the original study,[101] internal consistency for the whole scale ($\alpha = 0.85$) and for six critical items found on discriminant function analysis ($\alpha = 0.83$) was good. Snow *et al.*[102] reported internal consistencies of 0.80 and 0.74, respectively, in a sample of clinically referred 18- to 48-month-old children. However, both papers were judged to be of poor quality for this property, as the unidimensionality of the scale was not checked. Snow *et al.*[102] used the Social Communication Questionnaire (SCQ) to assess criterion validity and found a correlation of 0.77. Inada *et al.*[103] tested inter-rater reliability (mother–father pairs, $r = 0.93$) and test–retest reliability ($r = 0.99$) after a mean of 8 days in a Japanese translation; however, the paper had a small sample and so was judged to be poor.

Parent Observation of Early Markers Scale

The Parent Observation of Early Markers Scale (POEMS) is a new parent report instrument to monitor prospectively the behavioural development of infants at risk for ASD.[104] The target age is 1–24 months, and the development study involved 108 infants. POEMS includes 61 items that are rated on a four-point scale. Internal consistency was good at each of six age groupings. Test–retest reliability over a 1-month period was checked at 11 different age groupings and was high (with one exception); however, the evidence is of poor quality given small sample sizes. Convergent and divergent validity were established for the POEMS through correlations with domains of the Ages and Stages Questionnaire.[105] Relationships with the ASQ were stronger with the core features of ASD (social and communication problems) than with gross motor problems; however, the correlations with social and communication domains were only –0.41 and –0.45, respectively.

Pervasive Developmental Disorders Rating Scale

The Pervasive Developmental Disorders Rating Scale (PDDRS)[106] is a rating scale designed to assist in the screening and diagnostic process for autistic disorder. It contains 51 items, which comprise three subscales: Arousal, Affect and Cognition. Items are rated by a parent (or teacher who has known the individual for at least 2 months) on a five-point Likert scale according to the degree of severity of the behaviour described. Two papers were evaluated.[42,107] Williams and Eaves[107] reported on 456 participants with a diagnosis of ASD ranging in age from 1 to 12 years (as well as 111 adolescents and young adults). Ratings by the same teacher at a mean interval of 9.5 months, with 62.5% of the ratings having a ≥ 6-month time gap, were used to assess test–retest reliability; reliability coefficients ranged from 0.86 to 0.92 for subscales, and 0.92 for the total score. Internal consistency was also good, with subscale Cronbach's alpha coefficients ranging from 0.75 to 0.86, and total score of 0.89. The second paper[42] considered teacher ratings of 168 children aged 1–12 years. EFA found three factors, accounting for 64% of the variance, with internal consistency at least 0.80; however, because of the low sample size in relation to number of items, the evidence was judged to be poor.

Real Life Rating Scale

The Real Life Rating Scale (RLRS)[108] is a behavioural rating scale used in the diagnosis of autism; in comparison with other such scales it is noted to place emphasis on disturbances in response to sensory stimuli. The 47 items of the RLRS are completed by trained assessors, for example in Sturmey *et al.*,[61] based on clinical assessment observations of children during a 30-minute free play period. Sturmey *et al.*[61] examined internal consistency; this was good for the total score ($\alpha = 0.84$) but poor for the subscales, ranging from 0.42 to 0.68. However, the sample was small – 34 children and adolescents with a diagnosis of ASD – and so the evidence was judged to be poor. Similarly, Sevin *et al.*[109] reported on inter-rater reliability for a small sample of 24 children and adolescents. Reliability was poor for the 40 items observed, with mean agreement-level kappa = 0.31, and the highest-item kappa = 0.64 (disturbs others).

Social Communication Questionnaire

The SCQ (originally called the Autism Screening Questionnaire)[110] is a 40-item questionnaire based on the ADI-R,[63] which enquires about characteristic autistic behaviours. Parents are asked to indicate whether or not their child shows a particular symptom (current), and whether they did so at age 4–5 years (lifetime). Language items not suitable for non-verbal children can be omitted. Scores are out of a total of 39 or 32, depending on a child's language level, with higher scores indicating more severe symptoms.

The factor-based and total scores evidenced good-to-excellent scale reliability using confirmatory factor analysis parameters (factor loadings and error variances) in children with Down syndrome.[111]

Snow *et al.*[102] also found good internal consistency for total score ($\alpha = 0.81$); however, for the domain scores internal consistency was not good (Reciprocal Social Interaction domain 0.70; Communication 0.47; and Restricted, Repetitive, and Stereotyped Patterns of Behaviour 0.76). Magyar *et al.*[111] conducted EFA, which suggested a two-factor solution accounting for 54.4% of the variance: social communication, and stereotyped behaviour and unusual interests. Some evidence of criterion validity was found; for example, Magyar *et al.*[111] showed agreement of the two factor scores with corresponding domains in the ADI-R.

Charman *et al.*,[112] in a longitudinal study, aimed to compare the utility of three scales to measure developmental change in children's profiles over time. On the SCQ (current behaviour) there was no change in 57 children with ASD (aged < 6 years at the start), whereas on the VABS-Screener version (VABS-Screener) the children gained 9 months equivalent in 11 months on the Socialisation scale, and gained 10 months on the Communication scale. Therefore, evidence suggests that the SCQ does not detect change in measurement of autism characteristics when reduction in severity might have been expected.

Social Responsiveness Scale

The Social Responsiveness Scale (SRS)[113,114] is a 65-item questionnaire which takes 15–20 minutes to complete by parents, teachers or other adults who routinely observe the child in a naturalistic social setting. The item content of the two versions (36–48 months and 4–18 years) differs only on the basis of developmental appropriateness of the wording for rating the behaviours of children in the respective age groups, therefore they are considered together. Factor analyses support a one-factor solution; for example, principal components analysis revealed a primary factor explaining > 30% of the variance, with five factors accounting for 49% of the variance in total.[114] Good internal consistency[115,116] has been found for the total score. However, because of poor goodness of fit (e.g. differing relevance of items across ages), Duku *et al.*[116] have since explored a 30-item version that correlates strongly with the 65-item scale ($r = 0.94$). For reliability, findings were mixed. For the 36–48 months version, Pine *et al.*[117] reported reasonable maternal SRS test–retest reliability ($r = 0.74$) measured at variable intervals (6, 24 and 42 weeks) in a mixed sample; however, Bolte *et al.*[115] reported $r = 0.97$ in an older clinical sample, including children with ASD. Agreement between parents and teachers was found to be reasonable: $r = 0.78$;[118] ICC = 0.66,[117] whereas mother–father agreement in an older clinical sample was reported to be high[115] (0.97). Good convergent and divergent validity have been shown, for example, with the Child Behavior Checklist (CBCL),[115,116] and Bolte *et al.*[115] also showed good discrimination between groups at a total and at item level. For criterion validity, correlations even with the SCQ are moderate ($r = 0.58$) and lower with domains of the ADI-R (e.g. $r = 0.46$ with the Social domain).

Global measure of outcome

For details, see *Table 7*.

Autism Treatment and Evaluation Checklist

The Autism Treatment and Evaluation Checklist (ATEC)[119] is a 77-item, one-page checklist designed to be completed by parents, teachers and/or primary caretakers of children with ASD and to measure response to treatment. Three papers considering measurement properties of the ATEC were reviewed. One study[120] assessed internal consistency and found Cronbach's alpha coefficients for the four subscales to range from 0.86 to 0.96. Owing to the small sample size ($n = 22$), this paper was judged to be of poor methodological quality. Two studies[120,121] assessed convergent validity and found correlations between the ATEC and the British Picture Vocabulary Scale-II to range from –0.53 to –0.63, correlations with the Expressive One-Word Picture Vocabulary Test to range from –0.60 to –0.67, correlation with the VABS composite to range from –0.79 to –0.88, correlations with ADI-R total raw score to range from 0.82 to 0.88,[120] and correlation with the CARS of 0.71.[121] Two studies[112,120] assessed responsiveness. Charman *et al.*[112] found 50% of their hypotheses regarding change scores to be supported, whereas clear evidence of change was found for all subscales of the VABS-Screener (see *Table 11*, below). Magiati *et al.*[120] also found that 50% of ATEC scales

TABLE 7 Summary of quality: global measure of outcome

Tool (number of papers)	Internal consistency	Reliability: Test–retest	Reliability: Inter-rater	Content validity	Structural validity	Hypothesis testing: Convergent/divergent validity	Hypothesis testing: Known groups	Criterion validity	Responsiveness: Stability	Responsiveness: Change
Autism Treatment and Evaluation Checklist (3)	?					++				+/–
Behavioral Summarized Evaluation and Behavioral Summarized Evaluation-Revised (4)	?		+	+++	+/–	+	+	+		
Infant Behavioral Summarized Evaluation (1)			+		?					
Pervasive Developmental Disorders Behavior Inventory (2)	++		+/–	+++	++			–		

+++ or – – –, strong evidence; ++ or – –, moderate evidence; + or –, limited evidence; ?, unknown, owing to poor methodological quality; blank cell, no evidence available.

changed ATEC total scores at age 4–6 years significantly predicted the extent of progress made 5–6 years later. However, there were large individual differences in ATEC score changes over time.

Pervasive Developmental Disorders Behavior Inventory

The Pervasive Developmental Disorders Behavior Inventory (PDDBI) is an informant-based questionnaire that is designed to assess responsiveness to intervention in children diagnosed with ASD. The PDDBI items are organised into six *maladaptive* and four *adaptive* scales, with parent (176 items) and teacher (144 items) versions. The subscales independently address different types of behaviours, so that each subscale can be used separately or as part of the entire inventory. This is to enable researchers to assess, more frequently, behaviours that may change over the short term (e.g. stereotypies or aggressiveness), but, less frequently, other behaviours that would be expected to change over a longer time span (e.g. non-verbal prosocial skills or expressive language skills). The PDDBI development paper[122] described a comprehensive establishment of content validity from an initial large item pool and field testing. The authors then reported questionnaires completed by 311 parents of children with ASD between the ages of 1 and 17 years (mode 5 years). Alpha coefficients ranged from 0.79 to 0.97 in the parent version, and from 0.73 to 0.97 in the teacher version. Inter-rater reliability (between teachers, and between teachers and parents) was good for the verbally mediated subscales: Learning, Memory, and Receptive language; Phonological skills; and Semantic/pragmatic ability. Differences in agreement were most obvious for the Sensory/perceptual approach behaviours, Aggressiveness, and Social approach behaviours subscales. Principal components analysis of all subscales resulted in two factors together accounting for 65% of the variance. Separate factor analyses within subscales mostly found the predicted factor structure. Cohen[123] found significant correlations with the ADI-R subdomain Current behaviour scores, but all were < 0.60.

Social awareness

For details, see *Table 8*.

Communication and Symbolic Behavior Scales-Developmental Profile-Behavior Sample

The Communication and Symbolic Behavior Scales-Developmental Profile (CSBS-DP)[124,125] is a standardised tool for the assessment of communication and symbolic abilities of children in their second year of life. It consists of three measures: 24-item Infant–Toddler Checklist; Caregiver Questionnaire; and Behavior Sample, which is a face-to-face evaluation of the interaction between a child and parent, and clinician. Those three measures aim to assess a range of social, speech and symbolic skills. The one paper identified in stage 3[126] investigated the inter-rater reliability of the CSBS-DP-Behavior Sample, and reported *g* coefficients ranging from 0.92 to 0.97 for the composites and total score. However, a small sample was used (20% of the data) so the evidence is judged to be poor.

Early Social Communication Scales

The Early Social Communication Scales (ESCS)[127,128] measures non-verbal social communication, through rating by a trained investigator of directly observed skills in social interaction, joint attention and behaviour regulation, in children up to 30 months of age. The live scoring [Early Social Communication Scales Live (ESCS-L)] is an abbreviated version of the original ESCS coding scheme.[128] Inter-rater reliability was calculated in the one paper reviewed[129] and the average percentage agreement was 88.3; however, only a proportion of the sample was used in this analysis so the evidence was judged to be poor.

Imitation Battery

The Imitation Battery (IB)[130] examines imitation skills in children, including those diagnosed with ASD. Luyster *et al.*[129] presented a nine-item battery of manual actions, oral–facial actions and actions on objects to 164 toddlers with ASD, aged 18–34 months. Inter-rater reliability of the IB was reported as 97.2% agreement but the sample size (10%) was small. Young *et al.*,[131] who used a 10-item battery, reported inter-rater reliability with a mean weighted kappa statistic of 0.84. This study also found, as hypothesised,

TABLE 8 Summary of quality: social awareness

Tool (number of papers)	Internal consistency	Reliability: Test–retest	Reliability: Inter-rater	Content validity	Structural validity	Hypothesis testing: Convergent/divergent validity	Hypothesis testing: Known groups	Criterion validity	Responsiveness: Stability	Responsiveness: Change
Communication and Symbolic Behavior Scales-Developmental Profile-Behavior Sample (1)			?							
Early Social Communication Scales Live (1)			?							
Imitation Battery (2)			++				++			
Imitation Disorders Evaluation scale (1)			?		?					
Motor Imitation Scale (1)						?				
Preschool Imitation and Praxis Scale (2)	+++		+		+++	?				
Social Communication Assessment for Toddlers with Autism (1)			?			?	?		?	

+++ or – – –, strong evidence; ++ or – –, moderate evidence; + or –, limited evidence; ?, unknown, owing to poor methodological quality; blank cell, no evidence available.
Note: Preschool Imitation and Praxis Scale measurement error = ?.

lower imitation abilities in the ASD group than in typically developing children, but not in the group with other developmental delays.

Imitation Disorders Evaluation scale

The Imitation Disorders Evaluation (IDE) scale[132] is a nine-item clinical scale evaluating atypical imitation in infants and young children with autism. Items are rated by a trained observer on a five-point Likert scale, ranging from 0 (behaviour never observed) to 4 (behaviour always observed). In the Malvy *et al.*[132] development paper, insufficient information is given on both inter-rater reliability (kappa statistics ranging between 0.4 and 1) and structural validity (72.9% of the total variance accounted for) to draw conclusions about the IDE scale measurement properties.

Motor Imitation Scale

The Motor Imitation Scale[133] was developed as a structured imitation assessment for children with ASD. It includes 16 tasks, split equally between object and body imitation tasks, half of those involving meaningful and half non-meaningful actions. Items are rated by a trained investigator on a three-point scale, with a '0' score when there is no imitation, '1' for an emerging response and '2' for exact imitation. Ingersoll and Meyer[134] investigated the relationship between imitation and other social-communication skills in 27 children with autism, average age 38.7 months. After controlling for developmental level, the total imitation score was found to be significantly and positively correlated with expressive vocabulary ($r = 0.36$); however, the sample size used in the study was small so the evidence was judged poor.

Preschool Imitation and Praxis Scale

The Preschool Imitation and Praxis Scale (PIPS)[135] is a 30-item observational scale with 10 task categories (six gestural, three procedural and one facial) assessing imitation performance in young children. In the development paper, Vanvuchelen *et al.*[135] reported good overall internal consistency (Cronbach's $\alpha = 0.97$) and a four-factor structure explaining 66.6% of the variance. Also they found positive and strong associations (amid $r = 0.59$ and 0.74) between the PIPS score and scores on language and motor measures in children with ASD. The second paper reviewed on the measurement properties of the PIPS[136] demonstrated excellent inter-rater reliability for the scale (ICC = 0.986) and investigated the smallest detectable difference for the scale.

Social Communication Assessment for Toddlers with Autism

The Social Communication Assessment for Toddlers with Autism (SCATA)[137] is a semistructured observational tool eliciting social communication behaviours in young children with ASD with an unfamiliar adult. Four dimensions of communicative act are scored: form, function, communicative role and complexity. Reliability was found to be excellent for the total number of communication acts (ICC = 0.93). Frequency of communication over time was stable in the study, with greater communication difficulties shown by children with more severe diagnosis. The early social communication scores were also associated with later language scores. However, the paper is judged to be of poor quality because of the small sample.

Restricted and repetitive behaviour and interests

For details, see *Table 9*.

Autism Diagnostic Interview-Revised

A total of 20 eligible papers assessed the ADI-R Restricted and Repetitive Behaviours and Interests domain. Internal consistency was assessed in five papers;[63,64,68,138,139] none reached the COSMIN cut-off for internal consistency (Cronbach's $\alpha > 0.70$) with the exception of the Snow *et al.*[68] paper, for which Cronbach's alpha coefficient was 0.70 for verbal children but not non-verbal children (0.61). Test–retest reliability was assessed in two papers[63,140] but both were of poor quality. Inter-rater reliability was acceptable in three papers.[65,67,69] In all three papers[65,67,69] the raters were trained and monitored to maintain quality and consistency of ratings. Lord *et al.*[63] and Moss *et al.*[71] also assessed inter-rater reliability but the studies were of poor methodological quality due to small sample size.

TABLE 9 Summary of quality: RRBI

Tool (number of papers)	Internal consistency	Reliability		Content validity	Structural validity	Hypothesis testing		Criterion validity	Responsiveness	
		Test–retest	Inter-rater			Convergent/divergent validity	Known groups		Stability	Change
Autism Diagnostic Interview-Revised (20)	– – –	?	++	+++	+/–		+++		+	+
Autism Diagnostic Observation Schedule (7)	?	?	–	+	+/–			++	+	++
Autism Diagnostic Observation Schedule-Toddler Module (1)	–	+	?	+						
Repetitive Behavior Scale-Revised (2)	+++	?			– – –	++				

RRBI, restricted and repetitive behaviour and interests.
+++ or – – –, strong evidence; ++ or – –, moderate evidence; + or –, limited evidence; ?, unknown, owing to poor methodological quality; blank cell, no evidence available.

For content validity, Lord *et al.*[63] selected items that most closely resembled clinical descriptions and diagnostic guidelines from DSM-IV and ICD-10. By inspection of the face validity of constructs generated by factor analysis, Tadevosyan-Leyfer *et al.*[66] demonstrated that the ADI-R had good content validity. Thirteen papers,[63,67,68,74,138,141–148] of varying quality, assessed structural validity of the Restricted and Repetitive Behaviours and Interests domain with conflicting results. Four papers[68,138,141,142] provided results that supported the structural validity of the Restricted and Repetitive Behaviours and Interests domain of the ADI-R. Generally, a two-factor structure was found to be the best fit, with the factors labelled 'insistence on sameness' and 'repetitive sensory and motor behaviour'. Three papers of good quality did not provide enough information to assess structural validity.[143–145] However, three good-quality papers[67,146,147] and one paper,[148] judged as being of excellent quality, did not support the structural validity of the ADI-R Restricted and Repetitive Behaviours and Interests domain. In Frazier *et al.*[67] none of the factor solutions produced acceptable model fit, as RMSEA did not reach the < 0.06 cut-off or the Tucker–Lewis fit index > 0.95 cut-off. Lecavalier *et al.*[146] reported a three-factor solution accounting for just 38% of the variance. Similarly, Szatmari *et al.*[147] reported that a two-factor solution accounted for just 36% of the variance. Finally, the excellent quality paper[148] reported a two-factor solution accounting for 43% of the variance. Convergent and/or divergent validity was supported in all eight relevant papers. Both Lord *et al.*[63] and Grey *et al.*[74] showed that ASD and non-ASD groups differed significantly on RRB scores.

Responsiveness (in effect, stability) of the ADI-R was supported in two papers,[65,71] both of fair methodological quality. In the Moss *et al.*[71] study, there was no statistically significant change in the number of participants ($n = 35$, average age 3.5 years) meeting autism criteria on the ADI-R at follow-up after 7 years. Lord *et al.*[65] also demonstrated that ADI-R 'ever'/lifetime scores for restricted and repetitive behaviours and interests (RRBI) were higher at the age of 9 years than at 2 years, as expected, and that mean 'current' scores showed a marked reduction.

Autism Diagnostic Observation Schedule-Generic

Seven papers assessed one or more measurement properties of the ADOS-G in relation to RRBI. Lord *et al.*[50] assessed internal consistency, test–retest reliability and structural validity of modules 1–3; however, the methodological quality was poor for all assessments due to small sample sizes for each module. Inter-rater reliability did not reach the COSMIN criterion in Lord *et al.*[65] for modules 1 and 2.

Support for structural validity was excellent for module 1 but not for module 3, as none of the proposed models produced model fit statistics that satisfied the COSMIN criteria.[73] Kamp-Becker *et al.*[72] assessed the structural validity of ADOS modules 3 and 4 together, and showed that a four- and five-factor solution explained 52% and 57% of the variance, respectively. In the five-factor solution, factor 4 'stereotyped behaviour' and factor 5 'interests and compulsions' were relevant to the Repetitive and Restricted Behaviour domain of functioning.

Criterion validity was supported by Chawarska *et al.*[70] for module 1, with 91% of cases matching clinician-assigned diagnosis of autism. Grey *et al.*[74] provided good support for criterion validity in both modules 1 and 2 with high agreement between ADOS and clinical diagnosis ($\kappa = 0.70$; $p < 0.001$) and significant differences between ASD and non-ASD groups in the Repetitive and Restricted Behaviour domain.

Finally, three papers,[65,70,149] all judged as of fair methodological quality, supported the responsiveness of ADOS-G. Scores in the Stereotypic Behaviours domain were shown to be stable, as expected, over a period of 15 months.[70] The ADOS-G was able to measure improvement in functioning over time in Ben Itzchak *et al.*[149] and change scores for ADOS-G and ADI-R gave similar findings in Lord *et al.*[65]

Autism Diagnostic Observation Schedule-Toddler Module

The development paper[76] for the ADOS-Toddler Module reported poor internal consistency for the Repetitive and Restricted Behaviours domain (Cronbach's $\alpha = 0.50$). Test–retest reliability was moderate (ICC = 0.6) for RRBs for the verbal toddler algorithm but otherwise good. Inter-rater reliability was high, but the paper[76] was judged to be of poor quality for this property, as the measurement was for the agreement of seven raters and 14 videos of assessment. Luyster *et al.*[76] also reported that numerous drafts and pilot analyses for content validity were conducted, and items removed and added as appropriate.

Repetitive Behavior Scale-Revised

The Repetitive Behavior Scale-Revised[150] is a 43-item questionnaire designed to assess problem behaviour and was revised from the original RBS to tap into some of the complex RRBs observed in people with autism. The questionnaire is completed by parents/caregivers. The items have been conceptually grouped into six subscales: (1) Stereotyped behaviour; (2) Self-injurious behaviour; (3) Compulsive behaviour; (4) Ritualistic behaviour; (5) Sameness behaviour (insisting that things stay the same); and (6) Restricted behaviour/interests.

Both Lam *et al.*[151] and Mirenda *et al.*[152] provided evidence of good internal consistency for the overall score and for all subscales. Lam *et al.*'s[151] assessment of test–retest reliability was judged to be poor because of a small sample size. Structural validity was not supported, although in both cases statistical tests fell just below the COSMIN cut-offs. In Lam *et al.*,[151] 47.5% of the variance was explained by a four-factor solution. Five- and six factor solutions provided a good fit to the data in Mirenda *et al.*,[152] with RMSEA = 0.064, just missing the COSMIN cut-off of RMSEA = 0.06. Convergent validity was supported by both Mirenda *et al.*[152] and Lam *et al.*[151]

Sensory processing

For details, see *Table 10*.

Sense and Self-Regulation Checklist

The Sense and Self-Regulation Checklist (SSC)[153] is a 65-item caregiver questionnaire of children's sensory and self-regulatory difficulties, rated on a four-point Likert-type scale, ranging from '0' (never) to '3' (often). It contains six sensory subdomains (Touch–Pain; Auditory; Visual; Taste–Smell; Hyper-reactive to non-injurious stimuli; Hyporeactive to injurious stimuli) and six self-regulatory subdomains (Sleep, Appetite–Digestion, Self-soothing, Orienting–Attending, Aggressive behaviour, Self-injurious behaviour). Only one paper[153] considering measurement properties of the SSC was reviewed and used the SSC data from 265 children (including 99 children with ASD) aged < 6 years. The study[153] reports good internal consistency ($\alpha = 0.87$ for total) and acceptable test–retest reliability at 4 months interval ($r = 0.68$) and shows strong relationships between sensory and self-regulation impairment and severity of autism (however, only a subsample of 38 parents was used in the reliability study). The study showed predicted differences between children with ASD, and developmentally delayed and typically developing children, on the SSC.

Sensory Profile

The Sensory Profile (SP)[154] is a caregiver questionnaire that measures a child's sensory processing abilities. The questionnaire consists of 125 items, rated on a five-point Likert scale, ranging from almost never to almost always. The measure is divided into three main sections – Sensory Processing, Modulation, and Behavioural and Emotional Responses – and 14 sensory-processing categories. Children can also be classified as fitting into one of the four general sensory processing 'quadrants': sensation seeking, sensation avoiding, sensory sensitivity and low registration. The SP can be used with 3- to 10-year-olds. The reviewed paper[155] reported good known-groups validity of the SP between children with autism and typically developing children in the Australian sample.

Short Sensory Profile

The Short Sensory Profile (SSP)[154] is a 38-item, five-point Likert scale caregiver questionnaire intended to assess sensory processing and sensory systems. The questionnaire consists of seven factors: tactile

TABLE 10 Summary of quality: sensory processing

Tool (number of papers)	Internal consistency	Reliability		Content validity	Structural validity	Hypothesis testing		Criterion validity	Responsiveness	
		Test–retest	Inter-rater			Convergent/divergent validity	Known groups		Stability	Change
Sense and Self-Regulation Checklist (1)	?	–				+	+			
Sensory Profile (1)							+			
Short Sensory Profile (2)	?					+	++			

+++ or – – –, strong evidence; ++ or – –, moderate evidence; + or –, limited evidence; ?, unknown, owing to poor methodological quality; blank cell, no evidence available.

sensitivity, taste/smell sensitivity, movement sensitivity, seeking sensation, auditory filtering, low energy levels, and visual/auditory sensitivity. Two papers[156,157] looked at measurement properties of the SSP; however, in one of them,[156] an adapted version of the SSP was used, with 10 additional items from the SP,[154] and seven additional items from the researchers' clinical experience. In that study,[156] the information provided is not sufficient to determine the rating for internal consistency; however, it is reported that the SSP successfully classified 80.9% of the cases correctly among typically developing, learning-disabled children and those with autism. Wiggins *et al.*[157] found support for hypotheses that children with ASD show more sensory abnormalities than children diagnosed with developmental delays, and that sensory abnormalities are associated with stereotyped interests and behaviours as measured by ADOS.

Language

For details, see *Table 11*.

Comprehensive Assessment of Spoken Language

The Comprehensive Assessment of Spoken Language (CASL)[158] is a direct assessment of oral language skills in four areas: lexical/semantic, syntactic, supralinguistic and pragmatic. The subtests in the CASL can be either be administered individually or a total score can be obtained. In the Reichow *et al.* study,[159] six specific CASL subtests were examined: Nonliteral Language, Pragmatic Judgment, Antonyms, Syntax Construction, Paragraph Comprehension and Inference. The study[159] showed significant correlations between the Pragmatic Judgment and Inferences CASL subtests and the VABS Communication and Socialisation domains ($r = 0.45$; $r = 0.62$, respectively), suggesting that those two CASL subscales are not acceptable measures of language skills in individuals with ASD, as the correlation values were below COSMIN cut-offs.

MacArthur–Bates Communicative Development Inventories

The MacArthur–Bates Communicative Development Inventories (MCDI)[160,161] is a parent report of children's early language skills. It consists of two forms: 'Words and Gestures (Infant)' and 'Words and Sentences'. The former is an assessment of vocabulary comprehension, vocabulary production and use of gestures in infants between 8 and 16 months. The latter measures vocabulary production, sentence complexity, grammatical development and the mean length of the child's three longest utterances, in children between 16 and 30 months of age. Bruckner *et al.*[162] performed differential item functioning analysis and reported items that weakened the validity of the MCDI-Infant when scores of typically developing infants were compared with those with ASD. Luyster *et al.*[129] investigated associations between different measures of early language in toddlers with ASD, including both forms of MCDI. They reported high correlations between the MCDI, Mullen Scales of Early Learning (MSEL) and VABS (correlations between the MCDI receptive language scores and MSEL $r = 0.52$, and VABS $r = 0.77$; correlations between the MCDI expressive language scores and MSEL $r = 0.82$, and VABS $r = 0.88$).

Mullen Scales of Early Learning

The MSEL[163] is a developmental test for young children aged 0–69 months assessing visual reception, receptive language, expressive language and fine motor skills. One study[164] investigated the measurement properties of the MSEL. Burns *et al.*[164] found support for the hypotheses that children with developmental delays would present significantly more difficulties regarding expressive and receptive language skills than typically developing children matched for age, race and gender. Also the authors found that children with ASD were more likely to exhibit impairment in receptive language skills than children diagnosed with cerebral palsy.

Preschool Language Scale-Fourth Edition

The Preschool Language Scale-Fourth Edition (PLS-4)[165] is an assessment of language skills identifying children with language disability. It can be used with children up to 7 years of age and provides a total language score, auditory comprehension and expressive communication scores. Volden *et al.*[166]

TABLE 11 Summary of quality: language

Tool (number of papers)	Internal consistency	Reliability: Test–retest	Reliability: Inter-rater	Content validity	Structural validity	Hypothesis testing: Convergent/divergent validity	Hypothesis testing: Known groups	Criterion validity	Responsiveness: Stability	Responsiveness: Change
Comprehensive Assessment of Spoken Language (1)								–		
MacArthur–Bates Communicative Development Inventories (2)				+++		++				
Mullen Scales of Early Learning (1)							++			
Preschool Language Scale-Fourth Edition (1)						++				
Vineland Adaptive Behavior Scales (2)							+			?
Vineland Adaptive Behavior Scales-Classroom (1)						+				
Vineland Adaptive Behavior Scales-Screener (1)										++

+++ or – – –, strong evidence; ++ or – –, moderate evidence; + or –, limited evidence; ?, unknown, owing to poor methodological quality; blank cell, no evidence available.

investigated the relationship between language skills and both autism severity and adaptive communicative behaviour. The authors[166] reported a small correlation with ADOS scores ($r = -0.12$) and a strong correlation with the Vineland Adaptive Behavior Scales-Second Edition (Vineland-II) Communication domain ($r = 0.75$).

Vineland Adaptive Behavior Scales

The VABS[167] consist of a semistructured interview administered to the parent/carer or an adult with detailed knowledge of the functioning of the child. The ratings assess adaptive behaviour in four main domains: Communication, Daily Living Skills, Socialisation, and Motor skills (the last domain, however, is measured only for children of < 6 years of age). Also, the VABS includes a Maladaptive Behavior Scale. All of the items are rated on a three-point Likert scale, ranging from '0' (seldom or never present) to '2' (always present). One study[168] showed that 20 children with ASD (average age 47.4 months) made significant developmental progress in the Communication Skills domain of the VABS, from baseline to year 1 and year 2; however, the small sample means that the evidence was judged to be poor. Paul *et al.*[169] investigated differences between 20 children with autism and 20 diagnosed with PDD-NOS, aged 4–11 years. The authors found that group differences were observed only in very specific areas, but their hypothesis was supported with regard to use of expressive language.

Vineland Adaptive Behavior Scales-Classroom version

The VABS-Classroom version (VABS-Classroom) is a 244-item questionnaire that aims to assess adaptive behaviours in a classroom environment and is usually completed by teachers. Wells *et al.*[170] investigated the relationship between autism severity and adaptive behaviour, including communication skills. They reported correlations between autism severity (measured by CARS) and VABS-Classroom receptive language ($r = -0.27$, not significant) and expressive language ($r = -0.55$).

Vineland Adaptive Behavior Scales-Screener version

The VABS-Screener version (VABS-Screener)[171] is an adaptation of the VABS, with 45 items rated from '0' (when a child does not demonstrate behaviours) to '2' (when a child usually demonstrates a behaviour). Charman *et al.*[112] examined developmental change in children's profiles over 11 months. The sample of 40 children gained 10 age-equivalent months in communication skills. Also paired *t*-tests indicated that age equivalents at time 2 were significantly higher than at time 1 for communication skills.

Cognitive ability

For details, see *Table 12*.

Leiter International Performance Scale-Revised

The Leiter International Performance Scale-Revised (Leiter-R)[172] was designed to assess non-verbal cognitive ability in people with a variety of language complications. It is divided into two test batteries that include 10 subscales each. The Visualisation and Reasoning battery is used to obtain a composite IQ. The Attention and Memory subscales are used to evaluate deficits in Attention or Memory domains. Three papers[173–175] considering measurement properties of the Leiter-R were reviewed. The tool's convergent validity was assessed by two studies.[173,174] The first[173] found the Leiter-R to be moderately correlated with the Kaufman Brief Intelligence Test-Second Edition ($r = 0.62$). Tsatsanis *et al.*[174] found positive correlations (r ranged from 0.73 to 0.97) between the original Leiter International Performance Scale and Leiter-R IQ scores. However, the small sample size of this study ($n = 26$) led this paper to be judged as having poor methodological quality. One study[175] assessed the tool's known-groups validity, and found that only two of the study's four hypotheses were supported. The tool's criterion validity was assessed by Grondhuis and Mulick,[175] who found the Leiter-R to be moderately correlated (ICC = 0.66) with the non-verbal Stanford–Binet Intelligence Scales-Fifth Edition (SB5).

TABLE 12 Summary of quality: cognitive ability

Tool (number of papers)	Internal consistency	Reliability		Content validity	Structural validity	Hypothesis testing		Criterion validity	Responsiveness	
		Test–retest	Inter-rater			Convergent/divergent validity	Known groups		Stability	Change
Leiter International Performance Scale-Revised (3)						+	–	–		
Mullen Scales of Early Learning (2)							– –	++		
Mullen Scales of Early Learning-Early Learning Composite (1)							++			
Stanford–Binet Intelligence Scales-Fifth Edition (1)						+	–			
Wechsler Preschool and Primary Scale of Intelligence-Revised (1)										–

+++ or – – –, strong evidence; ++ or – –, moderate evidence; + or –, limited evidence; ?, unknown, owing to poor methodological quality; blank cell, no evidence available.

Mullen Scales of Early Learning

The MSEL[163] are a comprehensive measure of cognitive functioning in young children, and consist of four scales: Visual reception, Receptive language, Expressive language and Fine motor. Two papers[164,176] considering measurement properties of the MSEL when used with children with ASD were reviewed. Burns *et al.*[164] assessed known-groups validity (their sample included 19 children with ASD) and found support for only one of the study's two hypotheses. Bishop *et al.*,[176] in a sample of 59 children with ASD, assessed criterion validity and found correlations between the Differential Ability Scales and the MSEL Non-verbal IQ scores to equal 0.74, and MSEL Verbal IQ scores to equal 0.83.

An Early Learning Composite of the MSEL (MSEL-Early Learning Composite) can be calculated based on scores from four scales for children aged 0–69 months. One paper[82] considering the measurement properties of the MSEL-Early Learning Composite was reviewed. This study[82] assessed known-groups validity and found all relevant hypotheses to be supported.

Stanford–Binet Intelligence Scales-Fifth Edition

The SB5[177] evaluates general intellectual abilities. The full-scale IQ is derived from the Verbal and Non-verbal scales, each with five subtests bearing the same names: Fluid reasoning, Knowledge, Quantitative reasoning, Visual spatial processing and Working memory. One paper,[175] considering the measurement properties of the SB5, was reviewed. Grondhuis and Mulick[175] assessed known-groups validity and found that only two of the study's four hypotheses were supported. This same study[175] also assessed convergent validity and found the non-verbal SB5 to be moderately correlated (ICC = 0.66) with the Leiter-R.

Wechsler Preschool and Primary Scale of Intelligence-Revised

The Wechsler Preschool and Primary Scale of Intelligence-Revised (WPPSI-R)[178,179] assesses the intelligence of children aged between 3 and 7 years. One paper[180] considering the measurement properties of the WPPSI-R was reviewed. Yang *et al.*[180] assessed responsiveness and found R-squared for change in IQ from time 1 to time 2 was 0.50 in the total sample, and 0.37 in the ASD sample only.

Attention

For details, see *Table 13*.

Behavior Assessment System for Children-Second Edition

The Behavior Assessment System for Children-Second Edition (BASC-2)[181] is a widely used tool for assessing behaviour and emotions in children, adolescents and young adults, ranging in age from 2 to 25 years old. The BASC-2 consists of a Structured Developmental History, an Observation System, a Parent Rating Scale, a Self-Report of Personality Scale and a Teacher Rating Scale. Two papers[182,183] considering measurement properties of the BASC were reviewed. Hass *et al.*[182] found internal consistency of the Teacher Rating Scale only, as measured by Cronbach's alpha, to range from 0.66 to 0.85 for the Attention problems subscale. The absence of a factor analysis, however, led this paper to be judged to be of poor methodological quality. This same paper[182] assessed known-groups validity of the Teacher Rating Scale and found significant difference between groups on the Attention problems subscale. Mahan and Matson[183] assessed the known-groups validity of the Parent Rating Scale only, and found support for the hypothesis that the ASD group would score higher on the Attention problems subscale.

Child Behavior Checklist 1.5–5

The CBCL 1.5–5[184] is a norm-referenced measure that assesses for a wide range of emotional and behavioural disorders in children aged 1.5–5 years. It has 99 items, reported by parents on a three-point scale. Pandolfi *et al.*[185] found internal consistency, as measured by Cronbach's alpha, for items relevant to Attention Problems to equal 0.68. The same study[185] also found 27–52% of a typical item's variance was attributable to the single underlying factor.

TABLE 13 Summary of quality: attention

Tool (number of papers)		Reliability				Hypothesis testing			Responsiveness	
	Internal consistency	Test–retest	Inter-rater	Content validity	Structural validity	Convergent/divergent validity	Known groups	Criterion validity	Stability	Change
Behavior Assessment System for Children-Second Edition, Teacher Rating Scales (1)	?						+			
Behavior Assessment System for Children-Second Edition, Parent Rating Scales (1)							++			
Child Behavior Checklist 1.5–5 (1)	– –				++					
Child Behavior Checklist 6–18 (1)	++				– –					

+++ or – – –, strong evidence; ++ or – –, moderate evidence; + or –, limited evidence; ?, unknown, owing to poor methodological quality; blank cell, no evidence available.

Child Behavior Checklist 6–18

The CBCL 6–18[184] is a norm-referenced measure that assesses for a wide range of emotional and behavioural disorders in children aged 6–18 years. One study[186] considering measurement properties of this version of the CBCL 6–18 was reviewed. Internal consistency was good, with a median scale reliability of $r = 0.83$ for Attention Problems. Structural validity missed the cut-off for the Attention Problems scale [RMSEA > 0.06; comparative fit index (CFI) = 0.955].

Emotional regulation

For details, see *Table 14*.

Baby and Infant Screen for Children with aUtIsm Traits-Part 2

The BISCUIT-Part 2 is a 65-item parent questionnaire that was developed to assess infants and toddlers for comorbid mental health conditions reported as common in children with ASD. Internal consistency was reported as good,[83,187,188] as was inter-rater reliability.[188] The sample size was rather small for an adequate assessment of structural validity.[187] The BISCUIT-Part 2 was able to distinguish between children with and without ASD in two papers.[187,188] Finally, Matson, Fodstad *et al.*[188] provided supportive evidence of the criterion validity of the BISCUIT-Part 2, showing that scores were correlated as expected with diagnostic categorisation made by psychologists.

Behavior Assessment System for Children-Second Edition

The BASC-2 is tool widely used for assessing behaviour and emotions in children and young people (see *Attention*, above). Hass *et al.*[182] used the Teacher Rating Scale and reported that the BASC-2 had acceptable internal consistency for children ($n = 30$) for the Anger control ($\alpha = 0.75$), Emotional self-control ($\alpha = 0.86$) and Anxiety ($\alpha = 0.88$) scales. There were significant differences between ASD and matched control groups for the Anxiety (Cohen's $d = 1.23$), Anger control (Cohen's $d = 1.89$) and Emotional self-control scales (Cohen's $d = 1.94$). A second paper[183] also assessed known-groups validity of the BASC-2 using the Parent Rating Scale. ASD children scored significantly greater than typically developing children on the Depression subscale, but did not differ as expected on the anxiety and internalising composite scales.

Brief Infant–Toddler Social and Emotional Assessment

The Brief Infant–Toddler Social and Emotional Assessment (BITSEA) is a 42-item screener for parents and child-care providers, designed to identify children with social emotional/behaviour problems. The BITSEA has two scales: BITSEA/P measures emotional and behavioural problems, and BITSEA/C measures competence. Measurement properties were assessed in two papers.[189,190] Assessment of internal consistency was judged as methodologically poor in both papers.[189,190] Test–retest reliability was acceptable with 10- to 45-day test–retest ICCs of 0.87 for BITSEA/P and 0.85 for BITSEA/C.[189] Ratings by both parents were significantly correlated in both Briggs-Gowan *et al.*[189] (ICC = 0.68 for BITSEA/P and 0.61 for BITSEA/C) and Karabekiroglu *et al.*[190] (Spearman's correlation = 0.66 for BITSEA/P and 0.63 for BITSEA/C). However, agreement did not reach the COSMIN cut-off for acceptable inter-rater agreement. Agreement between parent and child-care provider was lower than between parents.[189] Hypothesis testing showed that the BITSEA had good convergent and divergent validity, and distinguished between toddlers with and without diagnosable social and emotional problems.

Child Behavior Checklist 1.5–5

The CBCL 1.5–5 behaviour scale was assessed by one paper[185] of good methodological quality. This paper[185] provided evidence of good internal consistency for the Internalising Behaviour domain (Cronbach's $\alpha > 0.70$) but was just below the COSMIN cut-off for the Emotionally reactive subscale (0.67) and the Anxious/depressed subscale (0.63). Structural validity was good overall, supporting the original factor structure of the Internalising and Externalising domains. However, model fit for a one-factor model for Emotionally reactive and

TABLE 14 Summary of quality: emotional regulation

Tool (number of papers)	Internal consistency	Reliability		Content validity	Structural validity	Hypothesis testing		Criterion validity	Responsiveness	
		Test–retest	Inter-rater			Convergent/divergent validity	Known groups		Stability	Change
Baby and Infant Screen for Children with aUtIsm Traits-Part 2 (3)	+++		+		?		++	++		
Behavior Assessment System for Children-Second Edition, Teacher Rating Scales (1)	?						+			
Behavior Assessment System for Children-Second Edition, Parent Rating Scales (1)							+/–			
Brief Infant–Toddler Social and Emotional Assessment (2)	?	+	– –			++	++			
Child Behavior Checklist 1.5–5 (1)	++				++					
Child Behavior Checklist 6–18 (1)	++				++			++		
Children's Global Assessment Scale (1)										+
Infant–Toddler Social–Emotional Assessment (1)	?		++				+++			

+++ or – – –, strong evidence; ++ or – –, moderate evidence; + or –, limited evidence; ?, unknown, owing to poor methodological quality; blank cell, no evidence available.

Anxious/depressed subscales did not reach the COSMIN cut-off of RMSEA of < 0.06 (RMSEA > 0.09 and 0.07, respectively) indicating that there may not be a single latent factor underlying these subscales.

Child Behavior Checklist 6–18

The CBCL 6–18[191] was assessed with a sample of 122 ASD youth (6–18 years) in one paper[186] of good methodological quality. Internal consistency was good, with a median scale reliability of $r = 0.94$ for anxious/depressed and 0.85 for withdrawn/depressed. Structural validity was also good for Anxious/depressed (RMSEA < 0.06; CFI = 0.995) but missed the cut-off for the Withdrawn/depressed scale (RMSEA > 0.06; CFI = 0.975). Overall, the analysis supported the original factor structure of the CBCL 6–18. Criterion validity was assessed by comparing ASD children with and without a co-occurring emotional and behavioural difficulty (EBD). Children with a co-occurring EBD scored significantly higher than those without EBDs on Anxious/depressed and Withdrawn/depressed subscales and on the Internalising domain.

Children's Global Assessment Scale

The Children's Global Assessment Scale (CGAS)[192] is a measure of overall psychosocial functioning (including home, school, with peers and across other settings). One study[193] was identified that measured responsiveness in a large sample of children attending child psychiatric outpatient services, including 1053 participants with ASD. Mean CGAS ratings improved between first visit to outpatient services and at case closure after treatment (the raters were not the clinicians involved in treatment but did have access to baseline rating when making the end-point rating). Change in CGAS ratings was significantly moderately correlated with clinician assessment of treatment response ($r = 0.47$).

Infant–Toddler Social–Emotional Assessment

The 169-item Infant–Toddler Social–Emotional Assessment (ITSEA)[194] is a parent-completed questionnaire that assesses three broad problem domains – Externalising, Internalizing and Dysregulation – along with Competence. Visser *et al.*[195] failed to report statistics for scale reliability (but did report mean ICCs of 0.7) for mothers and fathers, indicating acceptable inter-rater reliability. Visser *et al.*[195] and Georgiades *et al.*[82] both demonstrated that the ITSEA could distinguish between diagnostic groups. ITSEA Internalising and Externalising domains also correlated positively with the corresponding Internalising and Externalising domains of the CBCL and the Distraction and Mood scales of the Parenting Stress Index,[195] supporting convergent validity.

Physical skills

For details, see *Table 15*.

Mullen Scales of Early Learning

The MSEL[163] offer a developmental test for young children aged 0–69 months (see *Cognitive ability*, above), which includes direct assessment of fine motor skills, and in children of < 30 months gross motor skills are also examined. Burns *et al.*[164] found, as hypothesised, that children with developmental delays present significantly more difficulties regarding fine motor skills than typically developing children matched for age, race and gender.

Vineland Adaptive Behavior Scales

The VABS[167] provide a structured interview measuring adaptive behaviour in four main domains: Communication, Daily Living Skills, Socialisation and Motor Skills. Motor Skills is measured only for children of < 6 years of age. One study[168] showed that children with autism made significant developmental progress in the Motor Skills domain of the VABS, from pretest to year 1 and year 2.

TABLE 15 Summary of quality: physical skills

Tool (number of papers)	Internal consistency	Reliability		Content validity	Structural validity	Hypothesis testing		Criterion validity	Responsiveness	
		Test–retest	Inter-rater			Convergent/divergent validity	Known groups		Stability	Change
Mullen Scales of Early Learning (1)							++			
Vineland Adaptive Behavior Scales (1)										?
Vineland Adaptive Behavior Scales-Screener (1)										++

+++ or – – –, strong evidence; ++ or – –, moderate evidence; + or –, limited evidence; ?, unknown, owing to poor methodological quality; blank cell, no evidence available.

Vineland Adaptive Behavior Scales-Screener version

The VABS-Screener[171] is an adaptation of the VABS. Charman *et al.*[112] examined developmental change in children's profiles over 11 months. The sample of 40 children gained 5.5 age-equivalent months in Motor Skills. Also paired *t*-tests indicated that age equivalents at time 2 were significantly higher than at time 1 for Motor Skills.

Social communication

For details, see *Table 16.*

Autism Diagnostic Interview-Revised

Fourteen papers[63,65–72,139,140,146,196,197] were reviewed considering measurement properties of the ADI-R in relation to Communication. Four studies[63,68,139,146] assessed internal consistency, which found Cronbach's alpha coefficient from 0.45 to 0.83 for the Communication domain. Six studies[63,65,67,69,71,196] assessed inter-rater reliability of the Communication domain; 78% agreement was reported between raters by Robertson *et al.*[196] and kappa statistics ranging from 0.69 to 1.0.[63,65,67,69,71] The small sample size of three studies[63,71,112,195] led these papers to be judged as methodologically poor. One paper[140] found test–retest reliability for the Communication domain to be 0.73. However, the small sample size ($n = 20$) led this paper[140] to be judged as being of poor methodological quality. Two studies[63,66] assessed content validity and found that most items were considered relevant for the construct to be measured. Seven papers assessed structural validity providing contradictory conclusions (see *Autism symptom severity*, above). One paper[197] found good structural validity for 28 social communication items but the paper was judged of poor quality. Three studies[66,68,146] assessed convergent validity and found correlations between the ADI-R Communication domains and the VABS, the Aberrant Behavior Checklist (ABC), the Children's Yale–Brown Obsessive Compulsive Scale, the Child's Symptom Inventory, the Ritvo–Freeman Real Life Rating Scale, the Expressive Vocabulary Test and the Peabody Picture Vocabulary Test to range from –0.47 to 0.30. Three studies[63,69,196] assessed known-groups validity and found > 75% of the study hypotheses were supported. One study[70] assessed criterion validity and found the correlation between the ADI-R Communication domain and clinician impression to equal 0.49. Two studies[65,71] assessed responsiveness and found that 75% of the hypotheses regarding stability in scores were supported.

Autism Diagnostic Observation Schedule-Generic

The original ADOS study[50] assessed internal consistency and found Cronbach's alpha coefficients to range from 0.74 to 0.84 for the Communication domain. Three studies[50,65,72], assessed inter-rater reliability. Two of these studies[65,72] found kappa statistics to range from 0.60 and 0.80 on all items. However, the lack of methodological information regarding these analyses led the study by Kamp-Becker *et al.*[72] to be judged as having poor methodological quality. Lord *et al.*[50] reported good inter-rater reliability (ICC = 0.84) and test–retest reliability (ICC = 0.73) for the Communication domain across modules. Conclusions regarding structural validity, criterion validity and for responsiveness were as described for symptom severity (see *Autism symptom severity*, above).

Autism Diagnostic Observation Schedule-Toddler Module

Luyster *et al.*[76] presented the new Toddler Module of the ADOS (see *Autism symptom severity*, above). Internal consistency for all groupings was high (younger and non-verbal children: $\alpha = 0.88$; verbal $\alpha = 0.90$) for the Social Affect score. For inter-rater reliability, ICCs for the Social Affect total were 0.84 and 0.99, respectively; however, the small sample size ($n = 13$) led this to be judged as being of poor methodological quality. Test–retest reliability ICCs were 0.83 and 0.94; however, there were only eight children assessed twice in the older verbal group.

TABLE 16 Summary of quality: social communication

Tool (number of papers)	Internal consistency	Reliability: Test–retest	Reliability: Inter-rater	Content validity	Structural validity	Hypothesis testing: Convergent/divergent validity	Hypothesis testing: Known groups	Criterion validity	Responsiveness: Stability	Responsiveness: Change
Autism Diagnostic Interview-Revised (14)	+++	?	++	+++	+/–	– – –	+++	–	++	
Autism Diagnostic Observation Schedule-Generic (6)	?	+	+	+	+++			+/–	++	
Autism Diagnostic Observation Schedule-Toddler Module (1)	+	+	?	+						
Early Social Communication Scales Live (1)			?							
Social Communication Assessment for Toddlers with Autism (1)			?				?			

+++ or – – –, strong evidence; ++ or – –, moderate evidence; + or –, limited evidence; ?, unknown, owing to poor methodological quality; blank cell, no evidence available.

Early Social Communication Scales-Live

The ESCS-Live (ESCS-L) is an abbreviated version of the original ESCS observational coding scheme,[127] and is used as a measure of non-verbal social communication skills for children up to age 30 months. One study[129] assessed inter-rater reliability, and found that the average inter-rater reliability for this tool was 88.33%. Yet, owing to the small sample size for assessment of this property ($n = 16$), the paper was judged to be of poor methodological quality.

Social Communication Assessment for Toddlers with Autism

The SCATA[137] was designed to measure non-verbal communication, including early and atypical communication, in young children with ASD. Drew *et al.*[137] assessed inter-rater reliability and found the ICCs to range from 0.03 to 1.00, with 16 results of < 0.70 and 24 results of > 0.70. This same study[135] assessed known-groups validity and found most of the results to be in accordance with the hypotheses. However, the small sample sizes ($n = 17$ and $n = 23$) led both assessments from this study[135] to be judged as of poor methodological quality.

Social functioning

For details, see *Table 17.*

Autism Diagnostic Interview-Revised

Twelve papers[63,64–71,139,140,146] considering measurement properties of the Reciprocal Social Interaction domain of the ADI-R were reviewed. Four studies [63,68,112,139,146] assessed internal consistency; Cronbach's alpha coefficients were consistently good for Reciprocal Social Interaction, and higher than for other domains. Five studies[63,65,67,69,71] assessed inter-rater reliability and reported kappa statistics to range from 0.64 to 1.0. The small sample size of two studies[63,71] led these papers to be judged as being methodologically poor. One paper[140] found test–retest reliability for Reciprocal Social Interaction to be 0.84. However, the small sample size ($n = 20$) led this paper to be judged as being of poor methodological quality. Two studies[63,66] assessed content validity and found that most items were considered to be relevant for the construct to be measured. Seven papers[63,64–66,69,70,71] assessed structural validity providing contradictory conclusions (see *Autism symptom severity*, above). Two studies[64,66] assessed convergent/divergent validity. The former found ADI-R Reciprocal Social Interaction correlated with VABS scores as hypothesised, –0.41 to –0.45 (below the COSMIN criterion) and not with motor skills. Two studies[63,69] assessed known-groups validity and all of the study hypotheses were supported regarding Reciprocal Social Interaction. One study[70] assessed criterion validity and found the correlation between ADI-R Reciprocal Social Interaction and clinician impression to equal 0.46. Two studies[65,71] assessed responsiveness and found that all of the hypotheses regarding stability were supported.

Nisonger Child Behavior Rating Form

The Nisonger Child Behavior Rating Form (NCBRF)[198] is a rating scale designed to assess social competence and behaviour problems in children and adolescents with developmental disabilities. It has 76 items, completed by parents or teachers. Lecavalier *et al.*[199] assessed internal consistency and found alpha coefficients for the social competence items to range from 0.63 to 0.85 in a sample of 330 children and adolescents with ASD. Lecavalier *et al.*[146] assessed inter-rater reliability and report ICCs between the parent and teacher ratings to range from 0.17 to 0.23 on the social competence items. Their sample was 293 children with ASD, of whom one-third attended preschool or kindergarten. Test–retest reliability was also assessed,[146] and ICCs ranged from 0.63 to 0.73 for the social competence items. One study[199] assessing structural validity found RMSEA ranging from 0.000 to 0.031 for the social competence items. Lecavalier *et al.*[146] assessed convergent validity and found Spearman ranked correlation coefficients between Parenting Stress Index-Short Form (PSI-SF) and the social competence items of the NCBRF to range from 0.41 to 0.45.

TABLE 17 Summary of quality: social functioning

Tool (number of papers)	Internal consistency	Reliability		Content validity	Structural validity	Hypothesis testing		Criterion validity	Responsiveness	
		Test–retest	Inter-rater			Convergent/divergent validity	Known groups		Stability	Change
Autism Diagnostic Interview-Revised (12)	+++	?	++	+++	– – –	– –	+++	–	++	
Nisonger Child Behavior Rating Form (2)	++	–	–		++	–				
Vineland Adaptive Behavior Scales (3)		–					+			?
Vineland Adaptive Behavior Scales-Classroom (1)						+				
Vineland Adaptive Behavior Scales-Screener (1)										++

+++ or – – –, strong evidence; ++ or – –, moderate evidence; + or –, limited evidence; ?, unknown, owing to poor methodological quality; blank cell, no evidence available.

Vineland Adaptive Behavior Scales

The VABS[167] assesses four domains: Communication, Daily Living Skills, Socialisation and Motor Skills. Tyminski and Moore[200] assessed test–retest reliability and found that follow-up VABS Socialisation scores were positively related to baseline VABS scores ($r = 0.74$). Known-groups validity was assessed by Paul *et al.*,[169] who reported a significant difference between groups of children with autism and those with ASD in the Socialisation domain, as expected. Harris *et al.*[201] assessed responsiveness and found that children made significant improvements in the Socialisation domain. However, the small sample size ($n = 20$) led this study to be judged as being methodologically poor. One paper[170] considered measurement properties of the classroom edition of the VABS. This study[170] assessed convergent validity and found a correlation between Autism Severity, as measured by CARS and VABS-Classroom socialisation scale to equal –0.58. Measurement properties of the VABS-Screener[171] were assessed by Charman *et al.*,[112] who reported that the change score for the Socialisation domain was significant, with children making 9 months' progress in 11 months.

Play

For details, see *Table 18*.

Test of Pretend Play

The Test of Pretend Play (ToPP)[202] is an assessment of symbolic play ability in young children (aged between 18 months and 6 years). It assesses how children substitute one object for another, and refer to an absent object, as if it was present, and attribute an imaginary property to an object. Only one study[203] in our review investigated measurement properties of the ToPP. Clift *et al.*[203] reported a moderate positive correlation between the ToPP scores and language scores ($r = 0.41$), measured by FirstSTEP, a screening assessment used to identify children who may be at risk of developmental delay. The study[203] showed also that the ToPP correctly classified 75.9% of the participants (children with developmental problems and/or a psychological disorder, and typically developing children).

Behaviour problems

For details, see *Table 19.*

Aberrant Behavior Checklist

The ABC[204] is a 58-item caregiver report checklist designed to assess maladaptive behaviours in people with developmental disabilities. The ABC was assessed in three studies.[205–7] Internal consistency was reported as good (Cronbach's alpha coefficients ranged from 0.68 to 0.90) by Karabekiroglu and Aman,[205] whereas inter-rater reliability was reported as poor by Sigafoos *et al.*[206] (mean Spearman's rank correlation coefficient between parent and teacher ratings was 0.62, range 0.50–0.83). Brinkley *et al.*[207] demonstrated that the ABC had good structural validity, although the irritability subscale item placement did not match the standard ABC factor structure. One note of caution here is that in the ASD sample items on self-injury clustered into one factor and the remaining items from the standard ABC irritability subscale shifted to the hyperactivity subscale. Sigafoos *et al.*[206] also showed that the ABC had good structural validity, with five factors that closely matched the standard ABC factor structure; however, because of the small sample size ($n = 32$) this paper was judged of poor methodological quality. Known-groups validity and criterion validity were shown to be acceptable by Karabekiroglu and Aman.[205] The ABC distinguished between clinical subgroups and showed significant positive correlations with related constructs measured by the CBCL and the AuBC.

Baby and Infant Screen for Children with aUtIsm Traits-Part 3

The BISCUIT-Part 3[83] was designed to assess challenging behaviours. Internal consistency of the BISCUIT-Part 3 was reported as good with Cronbach's alpha coefficient of > 0.70 in two papers.[83,208] Structural validity, assessed in Matson *et al.*[208] was not acceptable, with EFA resulting in a three-factor solution explaining just 38.32% of the variance.

TABLE 18 Summary of quality: play

Tool (number of papers)	Internal consistency	Reliability: Test–retest	Reliability: Inter-rater	Content validity	Structural validity	Hypothesis testing: Convergent/divergent validity	Hypothesis testing: Known groups	Criterion validity	Responsiveness: Stability	Responsiveness: Change
Test of Pretend Play (1)						++	++			

+++ or – – –, strong evidence; ++ or – –, moderate evidence; + or –, limited evidence; ?, unknown, owing to poor methodological quality; blank cell, no evidence available.

TABLE 19 Summary of quality: behaviour problems

Tool (number of papers)	Internal consistency	Reliability: Test–retest	Reliability: Inter-rater	Content validity	Structural validity	Hypothesis testing: Convergent/divergent validity	Hypothesis testing: Known groups	Criterion validity	Responsiveness: Stability	Responsiveness: Change
Aberrant Behavior Checklist (3)	+		–		+++		+	+		
Baby and Infant Screen for Children with aUtIsm Traits-Part 3 (2)	+++				– – –					
Behavior Assessment System for Children-Second Edition, Parent Rating Scales (2)	+						+/–			
Child Behavior Checklist 1.5–5 (1)	++				++					
Child Behavior Checklist 6–18 (1)	++				++			++		
Home Situations Questionnaire-Pervasive Developmental Disorders version (2)	+++				+++	+++				+++
Nisonger Child Behavior Rating Form (2)	++	+	–		– –	+				

+++ or – – –, strong evidence; ++ or – –, moderate evidence; + or –, limited evidence; ?, unknown, owing to poor methodological quality; blank cell, no evidence available.

Behavior Assessment System for Children-Second Edition, Parent Rating Scales

The BASC-2, Parent Rating Scales is an omnibus instrument widely used for assessing behaviour and emotions in children and young people (see *Attention*, above). Hass *et al.*[182] showed that the BASC-2 had acceptable internal consistency for the 10-item Aggression scale and the nine-item Conduct problem scale. There were also significant large differences between children with ASD and matched control subjects on the Aggression scale (Cohen's $d = 0.58$) and the Externalising problems composite scale (Cohen's $d = 0.75$). Mahan and Matson[183] also assessed known-groups validity of the BASC-2. ASD children scored significantly greater than typically developing children on the Conduct problems and Externalising composite scales but did not differ as expected on the Aggression subscale.

Child Behavior Checklist 1.5–5

The CBCL 1.5–5 Behaviour scale was assessed by one paper[185] of good methodological quality. This paper provided evidence of good internal consistency for total problems (Cronbach's $\alpha = 0.93$) and both the Externalising Behaviour domain (Cronbach's $\alpha = 0.90$) and Aggressive behaviour subscale (Cronbach's $\alpha = 0.80$). Structural validity was also good, with acceptable model fit for a one-factor model for aggressive behaviour (RMSEA < 0.06; CFI > 0.95), indicating that there was a single latent factor underlying this subscale.

Child Behavior Checklist 6–18

The CBCL 6–18[191] was assessed with a sample of ASD youth in one paper[186] of good methodological quality. Internal consistency was good, with $r = 0.92$ for the Aggressive behaviour scale. Structural validity for the complete measure was good, and analysis supported the original two-factor structure of the CBCL 6–18 (internalising and externalising factors). Tests of unidimensionality of scales did not reach the cut-off for acceptable fit for aggressive behaviour (RMSEA = 0.10; CFI = 0.95); however, convincing arguments were provided to allow for correlated disturbances in the model for two-item pairs (destroys own things/destroys others things and disobedient at home/disobedient at school). This adjusted model demonstrated acceptable fit (RMSEA < 0.06; CFI > 0.95). Finally, criterion validity was assessed by comparing ASD children with and without a co-occurring EBD. Children with a co-occurring EBD scored significantly higher than those without EBDs on total problems. There were no significant differences between the two groups for aggressive behaviour or externalising behaviour. Given that the most commonly co-occurring EBDs were anxiety disorders, it is reasonable to assume that in this sample we would not expect to see group differences in aggressive or externalising behaviour.

Home Situations Questionnaire-Pervasive Developmental Disorders version

The Home Situations Questionnaire-Pervasive Developmental Disorders version (HSQ-PDD) is caregiver questionnaire designed to assess behavioural non-compliance in everyday situations by children with ASD. It was developed in studies of typically developing children, and was modified by Chowdhury *et al.*[209] and its properties assessed in a sample of 124 children with ASD, aged 4–13 years. Structural validity for a two-factor solution was a reasonable fit (RMSEA 0.06) and internal consistency good for the 25-item version thus derived ($\alpha = 0.90$ for the Socially inflexible subscale and $\alpha = 0.80$ for Demand-specific subscale). Known-groups validity and responsiveness (change over time) were also good for the HSQ-PDD. Responsiveness was shown related as hypothesised to change in the VABS Daily living skills scale.[210]

Nisonger Child Behavior Rating Form

The NCBRF[198] is a rating scale designed to assess social competence and problem behaviour in children with developmental disabilities. There are parent and teacher versions of the scale. Internal consistency of the problem behaviour scales was reported as good, with Cronbach's alpha coefficient of > 0.70 for all subscales in both parent and teacher versions.[199] Test–retest reliability for the parent version was reported to be strong (ICC for total problem behaviour > 0.80) but the teacher version fell short of the COSMIN criterion (ICC for total problem behaviour = 0.68); however, over a 1-year time interval some change might well be expected. Agreement was low between parents and teachers on common items from the parent and teacher version of the scale, indicating that inter-rater reliability was poor.[146] Structural validity was also shown to be poor for problem behaviour with a five-factor solution accounting for 47.5% of the variance.[199] Finally, Lecavalier *et al*.[146] provided fair evidence for divergent and convergent validity of the NCBRF.

Habit problems

For details, see *Table 20*.

Child Behavior Checklist 1.5–5

The CBCL[184] 1.5–5 was originally shown to measure two higher-order factors (internalising and externalising behaviour) and seven second-order factors (emotionally reactive, anxious/depressed, somatic complaints, withdrawn, attention problems, aggressive behaviour and sleep problems). One study[185] of good quality assessed the CBCL 1.5–5 in an ASD sample. Internal consistency was good for total scale and sleep problems ($\alpha > 0.80$) but not acceptable for somatic complaints ($\alpha = 0.49$). Structural validity was not acceptable for sleep problems (RMSEA = 0.13) but was acceptable for somatic complaints (RMSEA = 0.06), just reaching the cut-off for acceptable fit. Overall, the findings supported the original structure of the CBCL 1.5–5 but there were conflicting findings for the scales related to the Habit Problems domain.

Child Behavior Checklist 6–18

The CBCL 6–18[191] was assessed with a sample of ASD youth in one paper[186] of good methodological quality. Internal consistency was good, with a median scale reliability of $r = 0.85$ and $r = 0.88$ for somatic complaints. Structural validity was also strong for somatic complaints (RMSEA < 0.001; CFI = 1) and analysis supported the original factor structure of the CBCL 6–18. Criterion validity was assessed by comparing ASD children with and without a co-occurring EBD. Children with a co-occurring EBD scored significantly higher than those without EBDs on total problems and on the Somatic complaints subscale.

Sense and Self-Regulation Checklist

Silva and Schalock,[211] provided an assessment of the properties of the SSC (see *Sensory processing*, above). Internal consistency was rated as good with Cronbach's alpha coefficient of > 0.80 (range from 0.85 to 0.89). Although test–retest reliability overall did not reach the cut-off, the reliability coefficient was 0.83 for the Self-Regulation domain. This relates most closely to habit problems and so was considered supportive evidence of test–retest reliability. This paper[211] also demonstrated that the SSC was able to distinguish between children with and without ASD.

Daily living skills

For details, see *Table 21.*

Vineland Adaptive Behavior Scales

The VABS (see *Language and social functioning*, above) had two papers[168,169] that assessed domain-level validity[169] and responsiveness,[168] respectively. Paul *et al.*[169] demonstrated that children with autism and ASD differed on Communication and Socialisation domains but not on the Daily Living Skills domain. Groups did differ on 'phone use', which is part of the DLS scale but was deemed to be more relevant to verbal communication than daily living skills. Hypotheses were not specifically set out in the paper and so it was rated as 'fair' quality. Harris *et al.*[168] assessed rate of change and change in developmental age. This paper[168] showed that VABS was able to identify change over time but was of poor quality due to the small sample size ($n < 20$).

TABLE 20 Summary of quality: habit problems

		Reliability				Hypothesis testing			Responsiveness	
Tool (number of papers)	Internal consistency	Test–retest	Inter-rater	Content validity	Structural validity	Convergent/divergent validity	Known groups	Criterion validity	Stability	Change
Child Behavior Checklist 1.5–5 (1)	++				+/–					
Child Behavior Checklist 6–18 (1)	++				++			++		
Sense and Self-Regulation Checklist (1)	++	+					+			

+++ or – – –, strong evidence; ++ or – –, moderate evidence; + or –, limited evidence; ?, unknown, owing to poor methodological quality; blank cell, no evidence available.

TABLE 21 Summary of quality: daily living skills

		Reliability				Hypothesis testing			Responsiveness	
Tool (number of papers)	Internal consistency	Test–retest	Inter-rater	Content validity	Structural validity	Convergent/divergent validity	Known groups	Criterion validity	Stability	Change
Vineland Adaptive Behavior Scales (2)							–			?
Vineland Adaptive Behavior Scales-Classroom (1)							+			
Vineland Adaptive Behavior Scales-Screener (1)										++

+++ or – – –, strong evidence; ++ or – –, moderate evidence; + or –, limited evidence; ?, unknown, owing to poor methodological quality; blank cell, no evidence available.

Wells *et al.*[170] evaluated the VABS-Classroom. The paper[170] was rated as fair quality. The VABS-Classroom Daily living skills scale demonstrated convergent validity with mental age ($r = 0.87$) and severity of autism ($r = -0.46$).

Charman *et al.*[112] assessed responsiveness of the VABS–Screener tool in young children with ASD. This paper[112] was of good methodological quality and showed that there was developmental progress from time 1 to time 2 in daily living skills as predicted.

Global measure of functioning

For details, see *Table 22*.

Assessment, Evaluation, and Programming System

The Assessment, Evaluation, and Programming System[212] for infants and children is a curriculum-referenced comprehensive system assessing six key developmental areas in young children: Fine Motor, Gross Motor, Cognitive, Adaptive, Social Communication and Social. Each domain has 15–54 items: 228 in total. Wang *et al.*[213] assessed the internal consistency of the Social domain only and found the Cronbach's alpha coefficient to be 0.98. The same study[213] assessed the tool's responsiveness, and found significant change in the Social domain from pre-test and post test, as hypothesised. However, owing to the small sample size ($n = 22$), both assessments from this paper were judged to be of poor methodological quality.

Behavior Assessment System for Children-Second Edition

The BASC-2[181] is a tool for assessing behaviour and emotions in children, adolescents and young adults (see *Attention*, above). Hass *et al.*[182] report internal consistency of the Teacher Rating Scale, as measured by Cronbach's alpha, to range from 0.76 to 0.90 for the Adaptive Functioning subscales. The absence of a factor analysis, however, led this paper to be judged as being of poor methodological quality. Mahan and Matson[183] assessed the known-groups validity of the Parent Rating Scale and found that all relevant hypotheses were supported.

Psychoeducational Profile-Revised

The Psychoeducational Profile-Revised (PEP-R)[214] is used to assess abilities and formulate treatment programmes for children with autism and related developmental disorders. The tool consists of a Developmental scale, with a total of 153 items, and a Behavioural scale, with a total of 43 items. Four studies[215–218] assessed the internal consistency of the tool's Developmental scale and found that Cronbach's alpha coefficients ranged from 0.81 to 0.99. Three of these studies[216–218] also assessed internal consistency of the Behavioural scale and found that Cronbach's alpha coefficients ranged from 0.74 to 0.99. However, none of these studies included a factor analysis, and therefore all assessments were judged to be of poor methodological quality. Three studies[215,216,218] assessed the inter-rater reliability of the Developmental scale and found ICC values ranged from 0.84 to 0.99. Shek *et al.*[216] and Villa *et al.*[218] assessed the inter-rater reliability of the Behavioural scale and found that ICC values ranged from 0.56 to 0.88. Owing to small sample size, Alwinesh *et al.*[215] was judged to be of poor methodological quality. Two studies[215,216] assessed the test–retest reliability of the Developmental scale and found ICC values ranging from 0.87 to 0.99. Shek *et al.*[216] assessed the test–retest reliability of the Behavioural scale and found ICC values ranging from 0.76 to 0.92. Steerneman *et al.*[217] and Heimann *et al.*[219] both assessed known-groups validity and, in both, the relevant hypotheses were supported. However, the small sample size led the second study[219] to be judged as being of poor methodological quality. Two studies[215,217] assessed the tool's convergent validity and found correlations between the PEP-R and Snijders-Oomen Non-Verbal Intelligence Test-Revised to range from 0.90 to 0.95,[217] and correlations between PEP-R and Gesell's Developmental Schedule to range from 0.34 to 0.84.[215] Criterion validity was assessed by two studies,[216,218] and found correlations between PEP-R Developmental Score and VABS to equal 0.85,[218] and correlations between the PEP-R Developmental scale and Merrill–Palmer Scale of Mental Tests to equal 0.71.[216] Heimann *et al.*[219] assessed responsiveness and

TABLE 22 Summary of quality: global measure of functioning

		Reliability				Hypothesis testing			Responsiveness	
Tool (number of papers)	Internal consistency	Test–retest	Inter-rater	Content validity	Structural validity	Convergent/divergent validity	Known groups	Criterion validity	Stability	Change
Assessment, Evaluation, and Programming System (1)	?									?
Behavior Assessment System for Children-Second Edition, Teacher Rating Scales (1)	?									
Behavior Assessment System for Children-Second Edition, Parent Rating Scales (1)							++			
Psychoeducational Profile-Revised (5)	?	++	++			+++	+	++		?
Psychoeducational Profile-Third Edition (2)	+		+							?
Psychoeducational Profile-Third Edition, Caregiver Report (1)	?		–					?		
Scales of Independent Behavior-Revised (2)	+					?	+			
Vineland Adaptive Behavior Scales (2)							+			?
Vineland Adaptive Behavior Scales-Classroom (1)						+				
Vineland Adaptive Behavior Scales-Screener (1)										++

+++ or – – –, strong evidence; ++ or – –, moderate evidence; + or –, limited evidence; ?, unknown, owing to poor methodological quality; blank cell, no evidence available.
Note: Psychoeducational Profile-Third Edition measurement error = –.

found all relevant hypotheses regarding difference in change scores to be supported. However, the small sample size ($n = 20$) meant that this study[219] was judged to be of poor methodological quality.

Psychoeducational Profile-Third Edition

The third edition of the Psychoeducational Profile (PEP-3)[220] is specifically designed for children with ASD – ranging in developmental age from 2 years to 7 years 6 months – to assess their development of communication and motor skills and the presence of maladaptive behaviours. It consists of 10 performance subtests that are combined into three composites: Communication, Motor, and Maladaptive behaviours. Fu *et al.*[221] tested a Chinese translation; they assessed internal consistency and found Cronbach's alpha coefficients to range from 0.92 to 0.98. The same study[221] assessed inter-rater reliability, and found ICC of the PEP-3 ranged from 0.57 to 0.94 for the performance subtests, and 0.63 to 0.89 for the composites (4 out of 13 ICCs were < 0.70). This study also assessed measurement error, and found that the standard error measurement of the PEP-3 ranged from 2.6 to 6.5 for composite scores, whereas the smallest real difference of the PEP-3 ranged from 5.8 to 12.8. Chen *et al.*[222] assessed responsiveness and found that composite scores and most of the subtest scores of the PEP-3 changed in raw scores and developmental ages, but were stable in percentile ranks. Owing to the absence of specific hypotheses, this study[222] was judged to be of poor methodological quality.

Measurement properties of the Caregiver report of the PEP-3 were reviewed by Fu *et al.*,[223] who assessed internal consistency and found Cronbach's alpha coefficients to range from 0.15 to 0.85. However, as no factor analysis was conducted, this study[223] was judged to be of poor methodological quality. The same study[223] assessed inter-rater reliability and found the ICCs of the subtests ranged from 0.66 to 0.79, and criterion validity reporting correlation coefficients between the PEP-3-Caregiver and the VABS ranged from 0.04 to 0.82. However, the small sample size ($n = 20$) meant that this study was judged to be methodologically poor.

Scales of Independent Behavior-Revised

The Scales of Independent Behavior-Revised (SIB-R)[224] is a comprehensive norm-referenced test used to assess adaptive behaviour. It contains 14 subscales distributed into four areas: (1) Motor Skills; (2) Social and Communication Skills; (3) Personal Living Skills; and (4) Community Living Skills. Lecavalier *et al.*[146] assessed internal consistency and found Cronbach's alpha coefficients to range from 0.87 to 0.96. The same study[146] also assessed known-groups validity, and found support for the hypothesis. Brown *et al.*[225] assessed convergent validity and found that Full Scale IQ did not positively correlate with Broad Independence, and that Verbal IQ did not positively correlate with Social Interaction, as expected. However, the small sample size ($n = 25$) led this study to be judged as being of poor methodological quality.

Vineland Adaptive Behavior Scales

Paul *et al.*[169] explored the domains and subdomains of the VABS and assessed known-groups validity, finding support for all of their relevant hypotheses. Harris *et al.*[168] assessed responsiveness. A series of significant differences at years 1 and 2 were presented, but, owing to the lack of specific hypotheses, it is difficult to determine if the results were as expected. Therefore, the methodological quality of the paper was judged as poor.

Wells *et al.*[170] examined the measurement properties of the classroom edition of the VABS and reported convergent validity between the VABS-Classroom adaptive behaviour composite and CARS ($r = -0.53$).

The responsiveness of the Screener version of the VABS[171] was assessed.[112] The VABS-Screener age-equivalent domain scores showed clear evidence of developmental progress from times 1 to 2, although change in the composite score was not significant.

Parent stress

For details, see *Table 23*.

Autism Parenting Stress Index

The Autism Parenting Stress Index (APSI)[226,227] is a caregiver questionnaire designed for clinical use to identify what aspects of parenting skills would benefit from additional support, and to measure the outcome of intervention on parenting stress relative to core and comorbid symptoms of a child's autism. The measure consists of three categories: the core social disability, difficult-to-manage behaviour and physical issues. All of the items are rated on a five-point Likert scale, ranging from 'not stressful' to 'so stressful that sometimes we feel we cannot cope'. Only one study[153] has examined the measurement properties of the APSI, collecting data from parents of 274 children aged < 6 years (including 109 children with ASD). Authors reported good internal consistency and 4-month test–retest reliability (however, a subsample of only 18 parents was used). The factor analysis of the APSI revealed a four-factor solution (overall parental stress scale; core autism symptoms; comorbid behaviours; comorbid physical issues); however, the explained variance is not stated. The APSI discriminated between children with ASD and those who are typically developing or have other developmental delays.

Parenting Stress Index-Short Form

The PSI-SF[228] is a 36-item self-report questionnaire measuring parenting stress. It contains three subscales: Parental distress, Parent–child dysfunctional interaction, and Difficult child (the extent to which the parent considers the child to be 'difficult'). Items are rated on a five-point Likert scale ranging from 'strongly agree' to 'strongly disagree'. Three studies reported data on measurement properties of the PSI-SF. Lecavalier *et al.*[146] reported excellent internal consistency for the total score (Cronbach's $\alpha = 0.93$). Good internal consistency for the subscales, and support for a primary dimension for each of the PSI-SF subscales, were reported by Zaidman-Zait *et al.*[229] However, in Zaidman-Zait *et al.*[230] the three-factor model was rejected and a six-factor solution was suggested. Parenting stress was showed to be stable across time (over 1-year period) and associated with behaviour problems,[146] greater severity of autism and other psychological problems.[230]

Questionnaire on Resources and Stress-Friedrich Short Form

The Questionnaire on Resources and Stress-Friedrich Short Form (QRS-F)[231] is a 52-item questionnaire assessing the level of stress in families of children with disabilities. It contains four subcomponents of parental perceptions of difficulties: parent and family problems (stressful aspects of the impact of the child with disability on parents and the wider family), pessimism (parents' pessimistic beliefs about the child's future), child characteristics (features of the child that are associated with increased demands on parents) and physical incapacity (the extent to which the child is able to perform a range of typical activities). Honey *et al.*[232] investigated measurement properties of the QRS-F. A total of 174 mothers and 43 fathers of a child with autism aged between 26 and 82 months completed 31 items from the QRS-F (from the child characteristics, parent and family problems and pessimism scales). The authors reported good internal consistency for the total score. Support for the expected two- or three-factor solutions for the QRS-F was not found. The study[232] showed convergent validity of the QRS-F, with parents reporting more stress when raising children with more severe symptoms of autism and less stress if children were more able (as indicated by higher VABS scores).

TABLE 23 Summary of quality: parent stress

Tool (number of papers)	Internal consistency	Reliability		Content validity	Structural validity	Hypothesis testing		Criterion validity	Responsiveness	
		Test–retest	Inter-rater			Convergent/divergent validity	Known groups		Stability	Change
Autism Parenting Stress Index (1)	+++	?			?		++			
Parenting Stress Index-Short Form (3)	+++				+++	+			+	
Questionnaire on Resources and Stress-Friedrich Short Form (1)	+				?	+				

+++ or – – –, strong evidence; ++ or – –, moderate evidence; + or –, limited evidence; ?, unknown, owing to poor methodological quality; blank cell, no evidence available.

Discussion

The detailed data extraction and appraisal using the COSMIN checklist has provided some positive evidence with regard to at least one measurement property for 41 of the tools (seven with various versions/editions) identified as being used to measure an outcome at stage 2 of the MeASURe review. Nine other tools will not be considered further, either because the quality of the evidence provided in the paper(s) was of poor quality or the only measurement property evidence suggested that the tool was weak.

Unsurprisingly, the most evidence has been gathered for tools that were developed especially for use with children with ASD. Content validity has been accepted for this review as strong, even although it may not be represented in the tables; choice of autism characteristic items was assumed to have been addressed in other publications not considered in this review, as their focus would be on measurement properties concerning screening or diagnostic accuracy. There are some recurring issues with evidence concerning test–retest reliability, as this measurement property was not assessed or because the sample sizes were small, or the evidence reviewed was found to be inconsistent.

Despite the fact that one of the main aims of the review was to assess the property of responsiveness to change, there appears a dearth of evidence about which tools may have the capacity to track children's progress over time. In the case of tools such as the ADOS-G, designed to capture unusual quality of behaviours in order to aid diagnostic assessment, the property of stability in assessment may have been demonstrated and, in principle, this would allow detection of unexpected change. However, when a tool has been developed to measure a stable quality, the tool items may be insensitive to small changes in response to treatment. Even for the tools designed explicitly for the purpose of measuring change in response to intervention – ATEC and PDDBI – the evidence was limited. Some discussion of possible 'newer' tools will be included in *Chapter 5*.

The review also uncovered little evidence about the measurement properties of standardised assessments (e.g. of language, cognition and play) and for many questionnaires (e.g. assessing behaviour, attention and emotional regulation) when used with or about young children with ASD. Although for an individual child, the purpose of conducting an assessment may be to make comparison with patterns of typical development, this should be informed by a knowledge of what adjustments may need to be made to tools to take into account the particular ways in which children with ASD think and behave (content validity). For example, there is evidence that children with ASD on average have more expressive language than would typically be expected for their level of understanding of language.[233] Also the relative significance attributed to the observation that a young child chooses to play alone may not be the same for a child with ASD compared with their more typically developing peers.

This review has highlighted that there is relatively little information about inter-rater and test–retest reliability for questionnaire tools. Parents and teachers rating the behaviours of young children may well not agree, as they are likely to be observing the children in very different circumstances. However, the lack of test–retest reliability is concerning, and it would be appropriate for an agreed standard for an appropriate time interval between assessments to be agreed.

In our consultation with professionals (see *Chapter 2*), a number of tools were identified which are used in nurseries and other early years settings to monitor progress. We included in searches the Early Years Foundation Stage Profile; however, we identified no evidence about whether it has good measurement properties when used with children with ASD. The emphasis in early education tools is to record and monitor steps in building up skills, so that staff can plan learning activities for children. For this reason it would be reassuring to know whether one staff member made similar ratings to another staff member. The tools evaluated in the subdomain Global Measure of Functioning also included some that are used for individual programme planning (e.g. the AEPS, the Assessment of Basic Language and Learning Skills), again with insufficient information for their validity and appropriateness in use with young children with ASD.

We have found no evidence concerning tools that can describe and measure some of the aspects of children's social participation and well-being (valued by parents as important, see *Chapter 2*). We do have evidence about some tools that measure behaviour problems and distress. We have no evidence about measures of family quality of life, but some about measuring parent stress. The issue of emphasis on measurement of 'problems' rather than of strengths will be returned to in *Chapter 5*.

Chapter 5 Evidence synthesis

Introduction

The MeASURe systematic reviews have so far (1) identified the tools used in published intervention evaluation and observational studies with children with ASD up to the age of 6 years from 1992, and (2) assessed the availability and quality of information about the measurement properties of some of these tools.

This combined systematic review process appears to be unique in the field of autism. A few groups have previously made recommendations about batteries of tools for measuring outcome in autism (e.g. consensus decision by five research teams;[234] descriptive review of tools used[235]). These batteries have not been adopted for use consistently across research groups, and the measures considered in the first of these are not all applicable to young children (being largely focused on outcomes of medication trials for adults with autism and aggressive behaviour). Other papers review tools that have been frequently used: for example, Cunningham[236] reviewed measures of social interaction in autism and made recommendations without a clear basis of evaluation. Other reviews of assessment batteries have focused on diagnosis.[237] The field of autism research, practice and policy has expended massive efforts to standardise measurement practice internationally, but with the predominant focus on improvement of assessment for diagnosis.

Recently, the US Autism Speaks Foundation has supported expert work groups to evaluate outcome measurement tools in three subdomains: Restricted interests and repetitive behaviours; Anxiety; and Social Communication behaviours.[238–240] The purpose was to identify tools that were appropriate for use in medication trials. The expert groups identified, through systematic searches, tools used in treatment trials of medication, complementary medicine or behavioural interventions from 2005 to 2012, across any age group of children and youth with ASD. Other tools known to members of the work groups were also included. The tools were rated as: *appropriate*, *appropriate with conditions*, *potentially appropriate/ promising*, *unproven* or *not appropriate*. The definitions of each level included information on reliability, validity and sensitivity to change of the tool, use with individuals with ASD, and also aspects of burden in terms of the time and other difficulties associated with use of the tool in assessment. In each case, a small number of tools were identified as 'appropriate with conditions' (such as restricted age range or lack of information on sensitivity to change).

That process of evidence synthesis provides a helpful model but could not be adopted for the MeASURe project, as the US group's aim was different and narrower. The measurement properties and appropriateness of a tool vary depending on the use to which the tool will be put. In a randomised controlled trial of early intervention in ASD, for example, it is important to identify a primary outcome that can be assessed 'blind' and is responsive to change. In contrast, when monitoring children's progress in a nursery setting, properties of face validity, content validity, test–retest and inter-rater reliability, as well as burden (cost, training, time), will assume greater importance.

The approach to evidence synthesis adopted in this chapter is incremental. First, we present descriptive information on the 41 tools for which some positive evidence was found concerning their measurement properties (see *Chapter 4*). The information about some of these tools is amplified by points made by parents attending the advisory groups and by stakeholders who participated in the MeASURe Discussion Day (14 February 2014, described in *Chapter 2*). Second, we will briefly comment on other tools for which we were unable to identify evidence on measurement properties when used with young children with ASD, which may yet turn out to be 'promising' after further evaluation. Finally, we summarise the tools that may be, at present, the most appropriate choices, depending on the purposes of the researcher or clinician.

Methods

Descriptive information about each tool was compiled from a range of sources, including manuals, publishers' websites, papers citing the tool, summaries of tools presented on web pages, and so on. The MeASURe project team designed the headings for the tables, to include name, source, what it is described as measuring, method/respondent, potential for blinding, number of items/time taken, subscales, required interval between repeat administrations, age range, entry criteria, whether norms or clinical cut-offs are available, population for which designed, cost/availability/languages and training required. The judgement of potential for blinding is made on the assumption that parents/caregivers will know whether a child is receiving an intervention. (However, in a medication trial, parent report may be a blind outcome.) When the tool can be completed by education or other staff, there may be potential for blinding (although it would be poor practice for parents and staff not to communicate); there may also be potential for blinding where the parent is interviewed in a standard way to provide behavioural descriptions (and the parent has been asked not to unblind the interviewer). Where sources give conflicting information, the most recent version is presented.

Discussion Day

As described in *Chapter 2*, 25 participants came to a Discussion Day in London on February 2014, including parents, a young adult on the autism spectrum, researchers, and health and education professionals. In addition to the Q-sort activity described in *Chapter 2*, participants were divided into mixed groupings and asked to evaluate tools set out on display (four sets for each grouping). The subdomains represented were symptom severity, global measure of outcome, sensory processing, cognitive ability, behaviour problems and parent stress. Two direct child assessments were shown, with videotape accompaniment. The questionnaire tools were presented in pairs to allow participants to compare and contrast. Summary information about each tool was available. Participants rated each tool for (1) the assessment experience (including questionnaire wording) and (2) how likely it would be to capture change. They were asked also to state what they liked or did not like about the tool.

Descriptions of tools

The order of the paragraphs follows the Conceptual Framework of subdomains (see *Table 1*). However, the 41 tools are described once only, in the subdomain table in which they are presented most fully (see *Table 24*). The observational and intervention evaluation studies in which they were used are listed in *Appendix 5*.

Autism symptom severity

For details, see *Table 24*.

The AuBC was first published in 1978 and intended for the identification of autism in groups of children with severe disabilities. The items describe specific behaviours, although some include evaluation (e.g. item 19 'Has special abilities in one area – seems to rule out mental retardation'). Some items were judged to apply to neurotypical development. The scoring instructions were described by the Discussion Day participants as very confusing. However, the brevity of the scale was seen as positive. The participants did not consider the items would pick up change. This tool was used in three observational and six intervention evaluation studies in the review. The evidence on measurement properties was limited.

The ADI-R has been described in the literature as a 'gold standard' diagnostic tool. It has therefore been used in 15 longitudinal studies in this review, but not as an outcome measure in intervention. The time commitment to training and the cost of the tool are significant; the interview takes at least 2.5 hours but parents can find this investment of time and attention positive, as it allows them to describe in detail their child's strengths and difficulties. There is strong evidence for its measurement properties.

The ADOS was designed as a 'partner' diagnostic tool for the ADI-R. It was used in 14 observational studies, and 11 intervention evaluation studies in this review. However, there is considerable debate as to whether or not the ADOS can be sensitive to change, as each rating is measured on a three- or four-point scale, and the focus is on abnormalities of behaviour. A number of suggestions have been made for altered approaches to scoring[253] to enhance responsiveness to change. Reliable administration and scoring of the ADOS requires specific training of assessors; there is a self-training pack but attendance at a course is advised (which can be costly) and required for research-level competence. That it can be carried out by a 'blind' assessor is a definite strength. The participants at the Discussion Day were all positive about the child's experience, as ADOS focuses on the child's actual social and play behaviour. They did consider that it would capture change, although not for short-term interventions. However, it is only a 20- to 45-minute 'snapshot' of behaviour in a structured setting; another potential limitation for its use as an outcome measure. The current version [Autism Diagnostic Observation Schedule-Second Edition (ADOS-2)], published in 2012, includes some small modifications to procedure and ratings, with a revised scoring algorithm, and now includes the Toddler Module. The inclusion of five age- and ability-appropriate modules is a strength in allowing conceptually linked measurement longitudinally. The creation for ADOS-2 of a calibrated comparison score is intended to allow detection of changes over time but the utility of this score is yet to be evaluated.

The AOSI was used in two observational studies in this review, having been designed for research assessment of infant siblings of children with autism. As yet the information on its measurement properties is limited.

The BSE (revised, BSE-R) was developed in Tours, France; it was used in two European observational studies in this review and has been translated into English also, although its availability is unknown. It was specifically designed for professionals to monitor the progress of children in an autism-specific treatment nursery. The evidence on measurement properties is relatively strong. The Infant BSE derives from the same clinical research group, and was used in two observational studies in this review.

The CARS combines observation of the child and interview with parents/carers to enable a clinician to rate 15 items each on a seven-point scale. The primary purpose of the tool is for diagnosis. The CARS-2 includes a version for high-functioning children, as the original was not sufficiently discriminative in making diagnosis. The evidence on reliability was strong. CARS was used in 10 observational studies and three intervention evaluation studies in this review.

The GARS is primarily a parent questionnaire. It was used in four observational and four intervention evaluation studies in this review. The evidence on measurement properties was weak. The PDDRS is similar in purpose but with a different model underlying the subscales. It was used in one observational study in this review and lacks evidence of validity.

Three early screening tools were included, each having been used in one observational study, even although the tools are not primarily designed to measure outcome. The BISCUIT-Part 1, is a recent screening questionnaire, part of a suite of three tools for children with ASD. Initial testing of measurement properties is promising but reliability is unknown. The POEMS is recently published. The M-CHAT is a well-established screening tool; it is intended to be used by clinicians with parents/caregivers, or can be completed by parents themselves. The evidence concerning measurement properties is limited for both of these tools. The M-CHAT has a newly developed version,[249] which includes first a parent questionnaire and then administration by a clinician. As tools to measure outcome, these are limited by the short age range for which they were designed.

TABLE 24 Tools for assessing autism symptom severity

Name of the tool	Authors, date(s), history of revisions	What it claims to measure	Method and by whom measured/reported	No. of items and time taken	Subscales
Autism Behavior Checklist	Krug *et al.* (1978,[241] 1980[58])	Assess the behaviours and symptoms of autism	Q; parents or teachers Blinding: No/potential	57 items; 10–20 minutes Interval: NA	Five subscales: Sensory behavior; Social relating; Body and object use; Language and communication skills; Social and adaptive skills
Autism Diagnostic Interview-Revised	Lord *et al.* (1994);[63] Rutter *et al.* (2003)[53]	Diagnosis of autism, and distinguishing autism from other developmental disorders	I; parents or caretakers interviewed by trained assessor Blinding: potential	93 items; 90–150 minutes, including scoring Interval: NK	Three subscales: Language/ communication; Reciprocal social interactions; Restricted, repetitive, and stereotyped behaviours and interests
Autism Diagnostic Observation Schedule	Lord *et al.* (2000)[50] [current version: ADOS-2 (2012)][242]	Assessment of communication, social interaction, and play or imaginative use of materials for individuals referred because of possible ASD	O; clinicians Blinding: Yes	Module 1: 10 activities Modules 2 and 3: 14 activities Module 4: 15 activities 30–45 minutes Interval: (scores not affected by repeat administrations, ADOS-2, p. 15)	Five subscales: Language and communication; Reciprocal social interaction; Play; Stereotyped behaviors and restricted interests; Other behaviors Algorithm: communication and reciprocal social interaction
Autism Diagnostic Observation Schedule-Toddler module	Lord *et al.* (2012)[243] (part of ADOS-2)	Assessment of communication, social interaction, and RRBs relevant to the diagnosis of ASD in children with limited expressive language	O; clinicians Blinding: Yes	11 activities; 45 minutes (40–60 minutes) Interval: NK	Algorithm: Social affect and RRB
Autism Observation Scale for Infants	Bryson *et al.* (2008)[81]	Developed for research, a systematic method of detecting and monitoring signs of autism in high-risk infants	O; researchers Blinding: Yes	18 items; 20 minutes Interval: NK	NA

Age range and entry criteria	Whether norms available, clinical cut-offs	Population for which designed	Cost/availability/languages	Training required
Children aged ≥ 3 years	NK	ASD	No publisher	NA
Children and adults with a mental age > 2.0 years	Cut-offs for 'autism' for communication, social interaction, and repetitive behaviour domains	ASD	Forms and manuals are available from publisher ADI-R Kit (Interview Booklets; Algorithm Forms; Manual) US$237.00 Available in Danish, Dutch, English, Finnish, French, German, Hebrew, Hungarian, Icelandic, Italian, Japanese, Korean, Norwegian, Romanian, Russian, Spanish and Swedish	Training required before administering ADI-R DVD Training Package available (total running time 16 hours)
Toddlers to adults	Cut-offs for autism and autism spectrum (ADOS-2 includes a comparison score, i.e. the Calibrated Severity Score)	ASD	Available in Danish, Dutch, English, Finnish, French, German, Hebrew, Hungarian, Icelandic, Italian, Korean, Norwegian, Romanian, Russian, Spanish and Swedish	Training in a relevant professional discipline
12–30 months (who do not consistently use phrase speech), able to walk	Does not provide a cut-off score (provides ranges of concern instead)	ASD	Forms and manuals are available from publisher ADOS-2 Hand-scored Kit (manual; protocol booklets, test materials) US$1995.00 Available in Czech, Danish, Dutch, English, Finnish, French, German, Italian, Norwegian and Swedish	Training in a relevant professional discipline; training package and courses available
6–18 months	NA because of young age	ASD	NK	An examiner who is both skilled at interacting with infants and knowledgeable about ASD For research, training required by the Canadian team

continued

TABLE 24 Tools for assessing autism symptom severity (*continued*)

Name of the tool	Authors, date(s), history of revisions	What it claims to measure	Method and by whom measured/ reported	No. of items and time taken	Subscales
Baby and Infant Screen for Children with aUtIsm Traits-Part 1	Matson *et al.* (2009)[83]	Assessment of the core symptoms of autism in toddlers	Q; parents Blinding: No	62 items Interval: NA	Three subscales: Socialisation/ non-verbal communication; Repetitive behaviors/ restricted interest; Communication
Behavioral Summarized Evaluation (1990)[86] and BSE-Revised (1997)[87]	BSE: Barthelemy *et al.* (1990)[86] BSE-R: Barthelemy *et al.* (1997)[87]	Enable the formalisation of behaviour observations in the different domains in which specifically autistic difficulties occur	O; Clinicians and researchers Blinding: Yes	BSE: 20 items BSE-R: 29 items 5 minutes Interval: Once per month	Two subscales: Interaction disorder; Modulation disorder
Behavioral Summarised Evaluation-Infant	Adrien *et al.* (1992)[90]	Specifically related to the assessment of behaviours of young children with autistic disorders	O; clinicians Blinding: Yes	33 items; 10–15 minutes Interval: NK	Six subscales: Socialisation; Communication; Adaptation to environmental situations; Motility; Emotional and instinctual reactions; Attention–perception
Childhood Autism Rating Scale	Schopler *et al.* (1980, 1988)[92,244] (newest version: CARS-2: Schopler and Van Bourgondien (2010)[245]	Identify children with autism; distinguish them from developmentally delayed children who are not autistic; it also distinguishes mild-to-moderate from severe autism	O and Q; clinicians, teachers, parents Blinding: potential	15 items; 10 minutes Interval: NK	NA
Gilliam Autism Rating Scale	Gilliam (1995)[246] [newest versions: GARS-2 (2006)[100] and GARS-3 (2014)[247]]	Helps identify or diagnose autism and estimate its severity	Q; caregivers Blinding: No	56 items; 5–10 minutes Interval: NK	Four subscales: Stereotyped behaviors; Communication; Social interaction; Developmental disturbance (14 items each)
Modified Checklist for Autism in Toddlers	Robins *et al.* (1999)[248] [M-CHAT-R and M-CHAT-R/F (revised with follow-up, 2013, available)][249]	Identify children who may benefit from a more thorough developmental and autism evaluation	Q; to be administered to parents/guardians and interpreted by paediatric providers Blinding: Potential	23 items	NA

Age range and entry criteria	Whether norms available, clinical cut-offs	Population for which designed	Cost/availability/languages	Training required
17–37 months	Cut-offs for probable ASD/possible ASD	ASD	Available from Disability Consultants, LLC Kit (manual, protocols, score sheets) US$325 English	NA
1.5–12 years	A best cut-off to discriminate autistic from non-autistic children given in Barthelemy *et al.* (1997)[87]	ASD	French (English) A copy of the BSE-R can be obtained from C Barthelemy	A clinician who is both skilled at interacting with infants and knowledgeable about ASD
6–48 months	NK	ASD and developmental disorders	French and English [the English version can be found in Adrien *et al.* (1992)][90]	A clinician who is both skilled at interacting with infants and knowledgeable about ASD
Over 2 years	Cut-off scores for autism available	ASD	CARS-2 kit (manual, booklets) £148 English	Training in a relevant professional discipline
3–22 years	Cut-offs discriminating children with ASD from children without autism	ASD	GARS-3 from US$35 English	NA
16–30 months	Cut-offs discriminating between children diagnosed with and without autism/ASD	ASD	Free online M-CHAT with instant scoring www.m-chat.org/mchat.php Available in 45 languages	M-CHAT-R/F: First administration is parent report/questionnaire and follow-up administration is by a clinician/researcher

continued

TABLE 24 Tools for assessing autism symptom severity (*continued*)

Name of the tool	Authors, date(s), history of revisions	What it claims to measure	Method and by whom measured/ reported	No. of items and time taken	Subscales
Parent Observation of Early Markers Scale	Feldman *et al.* (2012)[104]	Screening of high-risk infants	Q; parents Blinding: No	61 items Interval: NK	NA
Pervasive Developmental Disorders Rating Scale	Eaves *et al.* (1993);[106] Eaves *et al.* (1987–88)[250]	Identify individuals with autistic disorder	Q; parents and teachers Blinding: No/potential	51 items Interval: NA	Three subscales: Arousal (22 items); Affect (19 items); Cognition (10 items)
Social Communication Questionnaire	Rutter *et al.* (2003)[251]	Provides a quick and easy routine screening for ASDs	Q; parent (two forms/versions: current and lifetime) Blinding: No	40 items, up to 10 minutes Interval: NA	NA
Social Responsiveness Scale (SRS-2 available, 2012)	Constantino and Gruber (2005)[252]	Can be used both as a screener and as an aid to clinical diagnosis	Q; parent and teacher Blinding: No/potential	65 items; 15–20 minutes, scoring 5–10 minutes Interval: NA	Five clinical scales: Social awareness (eight items); Social cognition (12 items); Social communication (22 items); Social motivation (11 items); Autistic mannerism (12 items)

I, interview; Interval, required interval between repeat administrations; NA, not applicable; NK, not known; O, direct observation including testing; Q, questionnaire.

Age range and entry criteria	Whether norms available, clinical cut-offs	Population for which designed	Cost/availability/languages	Training required
1–24 months	Total score cut-off score for autism diagnosis available (Feldman *et al.* 2012[104])	ASD	English	NA
NK	NK	General/ individuals with ASD	English	NA
Over 4 years, with a mental age of > 2 years	Cut-offs for likely ASD diagnosis	ASD	Forms and manuals are available from publisher SCQ Kit (AutoScore forms; manual) US$129.00 Available in Danish, Dutch, English, Finnish, German, Hebrew, Hungarian, Icelandic, Italian, Japanese, Korean, Norwegian, Romanian, Russian, Spanish, Swedish	Training in a relevant professional discipline
4–18 years (SRS-2 from 2.5 years)	Norms available	ASD	SRS-2 hand-scored Kit (manual, AutoScore forms) US$247 English	Training in a relevant professional discipline

The SCQ is a screening tool for all ages, and closely related to the ADI-R. It was used on one observational study and one intervention evaluation study in this review. The measurement properties evidence is relatively strong. The wording is, in places, complex (e.g. item 32: 'When she/he was 4 to 5, when she/he wanted something or wanted help, did she/he look at you and use gestures with sounds or words to get your attention?'); it was first developed with families who had already completed the ADI-R and so were familiar with they types of concepts included.

The SRS was developed to identify children with ASD. The original version was applicable from 4 years of age, but the Social Responsiveness Scale-Second Edition (SRS-2) includes a version for 2.5- to 4.5-year-olds. It was used in one intervention evaluation and two observational studies in this review. The measurement properties evidence is relatively strong, but the validity of the subscales is weak. At the Discussion Day, participants' opinions were generally favourable about the wording of items, as they include positive behaviours; however, parents commented that it would be difficult to complete item 29 ('Is regarded by other children as odd or weird'). The scale had clear instructions on how to complete it; however, a time frame of 6 months seemed too long for children in the age range up to 6 years. Participants thought that the scale would be likely to capture change. The linkage between age-related versions of the scale (into adulthood) is a strength.

Global measure of outcome

For details, see *Table 25*.

The two additional tools considered here also cover a range of symptoms of ASD, but have specifically been designed to capture change over time or with intervention.

The ATEC is presented either as one page or can be completed (and scored) online. The evidence about its measurement properties is limited. It was used in one observational study in this review. Participants at the Discussion Day found the presentation of items crowded and the item wording too short (and some 'unfriendly', such as describing the child as 'indifferent' or 'insensitive'). Many of the behaviours would not be the focus of intervention and therefore might be unlikely to change. They considered that a three-point rating scale might not have sufficient range to capture progress.

The parent version of the PDDBI is presented as six pages, with items scored on a four-point scale, with additional possibilities of 'U' (to indicate the child *used to* show this behaviour) or '?' (*don't know*). Participants at the Discussion Day found some of the language too technical and questioned the inclusion, for example, of detailed phonological skill items. Because of the large age range, some items are not appropriate for children aged < 6 years. The emphasis was on frequency, not impact of behaviours. No time frame is given for the responses. The PDDBI was used in two intervention evaluation studies in this review. The evidence on measurement properties was relatively strong but did not include responsiveness.

The Parent Interview for Autism-Clinical Version (PIA-CV)[254] emerged as a 'new tool' from searches, but no study was found in which the tool has been used to measure change with intervention. More recently, the Autism Impact Measure (AIM) has been presented.[255] The AIM targets measurement of short-term change in core ASD symptoms, asking parents to indicate frequency and impact of 25 behaviours over a 2-week recall period. The children in the development study were aged 2–17 years. Future evidence on the sensitivity to change of the PIA-CV and the AIM will be of great interest. Furthermore, another tool targeted at the age group up to 6 years is in development, the Brief Observation of Communication Change (Lord, Columbia University, New York, personal communication, July 2013). This tool is a rating of observed behaviours by a trained investigator, with categories based on ADOS ratings, as a child interacts in play with an adult. The 16 ratings are each on a six-point scale and the important metric is the difference from one occasion to another, in order to capture change.

Social awareness

For details, see *Table 26*.

We now describe tools that focus on core early impairments in autism, first tools that measure aspects of social awareness. Many such tools were designed specifically for a particular study, such as coding of observed parent–child interaction (see *Appendix 5*). Such tools are generally related to the focus of the intervention, and information about measurement properties is restricted to reliability in that study. A number of other scales used were searched for by name but the evidence concerning measurement properties was limited or poor quality.

The two scales for which some positive evidence was found focus on imitation. The IB and the PIPS were each used in one observational study in the review. The evidence on measurement properties was relatively strong for the latter. Detailed information is presented in the papers referenced in the table.

Repetitive behaviours and interests

For details, see *Table 27*.

Repetitive interests and behaviours are a core feature of autism and have most often been measured with diagnostic tools in this review. However, the RBS-R was used in one intervention evaluation study. The evidence for its measurement properties is somewhat mixed, particularly structural validity, and a three-factor model may be stronger.

Sensory processing

For details, see *Table 28*.

The SSC is based in concepts from Chinese medicine, and was developed for use in evaluation of Qigong massage. Evidence on its measurement properties is limited. Participants in the Discussion Day noted that there is no 'not applicable' response option for questions (e.g. about 'nappies'). The response scale measures frequency and not impact, without specification of a time frame. The phrasing of items was negative (e.g. 'haircuts are difficult').

The SP (and SSP) is a well-established clinical tool, although the review found little evidence on measurement properties in studies with children with ASD. Participants at the Discussion Day noted that the wording of items is negatively framed, the response scale captures frequency but not impact and there is no time frame. The SP was used in three observational and two intervention evaluations in the review, and the SSP in three observational studies.

TABLE 25 Tools for assessing global measure of outcome

Name of the tool	Authors, date(s), history of revisions	What it claims to measure	Method and by whom measured/ reported	No. of items and time taken	Subscales
Autism Treatment Evaluation Checklist	Rimland and Edelson (1999)[119]	Effectiveness of various treatments	Q; parents, teachers or caretakers Can be undertaken online Blinding: No/potential	77 items NK Interval: NA	Four subscales: Speech/language communication (14 items); Sociability (20 items); Sensory/ cognitive awareness (18 items); and Health/physical/ behaviour (25 items)
Behavioral Summarized Evaluation and BSE-Revised	(see *Table 24*)				
Infant Behavioral Summarized Evaluation	(see *Table 24*)				
Pervasive Developmental Disorders Behaviour Inventory	Cohen and Sudhalter (2003)[122]	Assesses both maladaptive and adaptive behaviours, creating a behavioural profile Assess responsiveness to intervention in children with ASD	Q; parents and teachers Blinding: no/potential	124 items standard forms, 188 items parent-extended, 180 items teacher-extended 30–45 minutes Extended Forms scoring time: 20–30 minutes Standard Forms; scoring time: 20 minutes Interval: NK	Domains: I. Approach/ Withdrawal Problems; II. Receptive/ Expressive Social Communication Abilities[a]

Interval, required interval between repeat administrations; NA, not applicable; NK, not known; Q, questionnaire.

a The parent version consists of 10 subscales and the teacher version eight subscales. Each subscale assesses a different type of maladaptive or adaptive behaviour associated with pervasive developmental disorder. The maladaptive subscales are as follows: (1) Sensory/perceptual approach behaviours (stereotyped and ritualistic behaviours); (2) Specific fears (of parental separation, sounds, people, etc.); (3) Arousal problems (hyperactivity, hyporesponsiveness; sleeping problems, etc.); (4) Aggressiveness or behaviour problems (self-injury, aggression, irritability, etc.); (5) Social pragmatic problems (social problems, such as inappropriate touching or lack of awareness of social issues, etc.); and (6) Semantic/pragmatic problems (aberrant vocal prosody, echolalia, perseveration and tangential speech). The adaptive subscales are (1) Social approach behaviours (responsive eye contact, joint attention, positive affective, referential gestures, etc.); (2) Learning, memory and receptive language (memory skills, semantic and syntactic concepts, etc.); (3) Phonological skills (production of vowel, consonant and diphthong speech sounds); and (4) Semantic/pragmatic ability (use of negatives, morphemes, qualifiers, pragmatic conversational skills, etc.).

Age range and entry criteria	Whether norms available, clinical cut-offs	Population for which designed	Cost/availability/languages	Training required
NK	NA (but percentile scores are given on the website)	ASD	Free to researchers; Autism Research Institute website (www.autism.com) Languages: English, Chinese (simplified), Italian, Turkish, Portuguese, German, Spanish, Russian, Romanian, French	NA
2–12 years	Age norms and standardised scores available	ASD	Forms and manuals are available from the publisher PDDBI Introductory Kit (manual, rating forms, score summary sheets, profile forms) US$285.00	Training in an appropriate professional discipline; additional training in competent use of psychological tests

TABLE 26 Tools for assessing social awareness

Name of the tool	Authors, date(s), history of revisions	What it claims to measure	Method and by whom measured/ reported	No. of items and time taken	Subscales
Imitation Battery	Rogers *et al.* (2003)[130]	Imitation skills in very young children, including children with ASD	O; clinicians Blinding: Yes	Nine tasks Interval: NK	Three categories: Manual acts; Actions on objects; Oral–facial movements
Preschool Imitation and Praxis Scale	Vanvuchelen (2009)[256]	Investigate bodily (gestural and facial) and procedural imitation in young children	O; clinicians Blinding: Yes	30 items; 10–20 minutes Interval: NK	Six gestural, three procedural and one facial

Interval, required interval between repeat administrations; NK not known; O, direct observation.

TABLE 27 Tools for assessing RRBI

Name of the tool	Authors, date(s), history of revisions	What it claims to measure	Method and by whom measured/ reported	No. of items and time taken	Subscales
Autism Diagnostic Interview-Revised	(see *Table 24*)				
Autism Diagnostic Observation Schedule	(see *Table 24*)				
Autism Diagnostic Observation Schedule-Toddler Module	(see *Table 24*)				
Repetitive Behavior Scale-Revised	Bodfish *et al.* (2000)[150] [original RBS, Bodfish *et al.* (1999)][258]	Measure the breadth of repetitive behaviour in children, adolescents, and adults with ASDs	Q; parents or caregivers Blinding: No	43 items; < 15 minutes Interval: NA	Six subscales: Stereotyped behavior; Self-injurious behavior; Compulsive behavior; Routine behavior; Sameness behavior; Restricted behavior

Interval, required interval between repeat administrations; NA, not applicable; NK, not known; Q, questionnaire.

Age range and entry criteria	Whether norms available, clinical cut-offs	Population for which designed	Cost/availability/languages	Training required
NK	NK	ASD	English Procedure and items description can be found in Rogers *et al.* (2003)[130]	NK
12–59 months of age	Cut-offs available	General	English and Dutch Procedure and items description can be found in Vanvuchelen *et al.* (2011)[257]	NK

Age range and entry criteria	Whether norms available, clinical cut-offs	Population for which designed	Cost/availability/languages	Training required
Children and adults	NK	ASD	English	NA

TABLE 28 Tools for assessing sensory processing

Name of the tool	Authors, date(s), history of revisions	What it claims to measure	Method and by whom measured/ reported	No. of items and time taken	Subscales
Sense and Self-Regulation Checklist	Silva, and Schalock (2012)[211]	Measure of comorbid symptoms in autism	Q; parents or caregiver Blinding: No	65 items Interval: NA	Two domains:[a] Sensory, Self-regulation
Sensory Profile (also available: Infant/Toddler Sensory Profile, and the Sensory Profile School Companion)	Dunn (1999)[154]	Measure a child's sensory processing abilities and to profile the effect of sensory processing on functional performance in daily life	Q; parents or caregivers Blinding: No	125 items Up to 25 minutes Interval: NK	Three main subscales: Sensory processing; Modulation; and Behavioural and emotional responses Nine factors: sensory seeking; emotional reactive; low endurance/tone; oral sensory sensitivity; inattention/ distractibility; poor registration; sensory sensitivity; sedentary; and fine motor/ perceptual
Short Sensory Profile	McIntosh *et al.* (1999)[259] (chapter 7 of *The Sensory Profile: User's Manual*[154])	Measures sensory modulation during daily life	Q; parents or caregivers Blinding: No	38 items Up to 10 minutes Interval: NA	Seven subscales: Tactile sensitivity, Taste/smell sensitivity, Movement sensitivity, Under-responsive/ seeks sensation, Auditory filtering, Low energy/weak, Visual/ auditory sensitivity

Interval, required interval between repeat administrations; NA, not applicable; NK, not known; Q, questionnaire.

a Sensory domain, six subdomains: Touch–pain, Auditory, Visual, Taste–smell, Hyper-reactive to non-injurious stimuli, and Hyporeactive to injurious stimuli; Self-regulation domain, six subdomains: Sleep, Appetite–Digestion, Self-soothing, Orienting–Attending, Aggressive behaviour and Self-injurious behaviour.

Age range and entry criteria	Whether norms available, clinical cut-offs	Population for which designed	Cost/availability/languages	Training required
Children aged < 6 years	NK	ASD	English copy available online: (www.midss.org) Available in English, Spanish and Chinese	NA
Most appropriate for 5–10 years, but can be used with 3- and 4-year-olds	Norms available	General	Sensory Profile Complete Kit (manual, caregiver questionnaires, short sensory profile, score sheets) US$196 Available in both English and Spanish	Occupational therapist; other professionals with post-qualification training in sensory processing
Most appropriate for children aged 5–10 years, but can be used with 3- and 4-year-olds	Norms available	General	(see above) Available in both English and Spanish	NA

Language

For details, see *Table 29*.

The MCDI are used extensively, and were identified in this review in seven intervention evaluation studies and seven observational studies. Parents indicate which words, from a list of vocabulary, that their child currently understands, and which the child understands and says. We did not find evidence about reliability in use with children with ASD; however, a recent study of children with autism aged 2–4 years found excellent agreement between parent and preschool teacher for the whole sample for both words produced and words understood (ICC = 0.93 and 0.77, respectively).[261] Shortened versions have been created for many languages, which could then be used in UK.

For both the direct assessments of language, the evidence for measurement properties in children with ASD was limited. The MSEL include two language scales. Both MSEL and the PLS are appropriate across the age range to 6 years. The PLS was used in nine observational studies and two intervention evaluation studies in this review.

Cognitive ability

For details, see *Table 30*.

The Leiter-R is a test of non-verbal intelligence, which may be advantageous for a range of children with neurodevelopmental impairments and limited language competence. As might be expected for a norm-referenced test, there is little specific evidence for the measurement properties of the Leiter, or the Stanford–Binet Intelligence Scales, in use with children with ASD. [We found no evidence for other such tests, such as the Bayley Scales of Infant Development (BSID) and the British Ability Scales (BAS).]

The MSEL includes five subscales, four of which make up the Early Learning Composite. The participants at the Discussion Day appreciated that the tasks have simple, developmentally appropriate materials and seem more like playing than a test. However, others found the materials ‘fiddly’ and not engaging. The participants commented that it would take a skilled administrator to avoid a child with ASD becoming anxious about getting tasks wrong (as would also be the case for any standardised test). The inclusion of Motor Skill domains was seen as an important part of the assessment, as this may be a particular area of weakness. The evidence about measurement properties in use with children with ASD did not include reliability. The MSEL was used in 32 studies included in the review, six of which were intervention evaluation studies.

The scales measuring ‘Attention’ are presented in later sections (see *Behaviour problems* and *Global measure of functioning*, below).

Emotional regulation

For details, see *Table 31*.

The BISCUIT-Part 2 is part of a set of three parent questionnaires. The evidence for its measurement properties was relatively strong, albeit all provided by the original research group. It was used in one observational study in this review. The remaining scales in this section are not ASD specific.

The Infant–Toddler Social–Emotional Assessment (and its Brief version) provides norms based on a national sample of children, including those who were preterm, had language delay, and children with other diagnosed disorders. The evidence for its measurement properties in children with ASD is relatively limited. The CBCL will be presented in the section on behaviour.

The CGAS is a clinician rating, giving a single summary score. As it covers a wide age range, the descriptions for each band of 10 scores do not necessarily apply to children up to the age of 6 years. Evidence of its measurement properties in ASD is lacking.

Physical skills, Social communication and Social functioning are presented under other headings.

Play

For details, see *Table 32*.

The ToPP is a direct assessment of a child's symbolic play skills; the clinician sets up scenes with materials and observes the child's actions. It was used in two observational studies in this review. The evidence on measurement properties when used with children with ASD is weak, with no information on reliability.

TABLE 29 Tools for assessing language

Name of the tool	Authors, date(s), history of revisions	What it claims to measure	Method and by whom measured/ reported	No. of items and time taken	Subscales
MacArthur–Bates Communicative Development Inventories (Words and Gestures, and Words and Sentences)	Fenson *et al.* (1993)[160]	In-depth information on the development of vocabulary, gestures, and/or grammar in children from 8 to 30 months of age	Q; parents	20–40 minutes Interval: NA (Standardisation sample collected at monthly intervals)	*Words and gestures*: major sections – phrases understood (28 items), vocabulary comprehension and production (396 words), and actions and gestures (63 items) *Words and sentences*: major sections – production vocabulary (680 words), grammatical complexity (37 items)
Mullen Scales of Early Learning	(see *Table 30*)				
Preschool Language Scale-Fourth Edition	Zimmerman *et al.* (2002)[165] (PLS-5 available since 2011)[260]	Measure young children's receptive and expressive language	O; testing by any professional who has experience and training in assessment practices Blinding: Yes	130 tasks (62 auditory comprehension tasks and 68 expressive comprehension tasks) 20–45 minutes Interval: NK (original standardisation sample collected at 6-monthly intervals)	Two subscales: Auditory comprehension, and Expressive communication
Vineland Adaptive Behavior Scales	(see *Table 34*)				

CDI, Communicative Development Inventories; Interval, required interval between repeat administrations; NA, not applicable; NK, not known; O, direct observation; Q, questionnaire.

Age range and entry criteria	Whether norms available, clinical cut-offs	Population for which designed	Cost/availability/languages	Training required
Words and Gestures (Infant form), 8–16 months; Words and Sentences (Toddler form), 16–30 months (Either form may be used with older, developmentally delayed children)	Norms available	General	CDI – complete kit (including user's guide, Words and Gestures, Words and Sentences, CDI III) US$121.95 English and Spanish Versions in multiple languages available at www.sci.sdsu.edu/cdi/	NA
Birth to 6 years 11 months	Norms available	General/ children with language disorder or delay	English and Spanish PLS-4 complete kit (including manual, 15 record forms, picture manual and manipulatives set) US$438.25	Training in a relevant professional discipline; training in administration, scoring and interpretation of clinical assessments

TABLE 30 Tools for assessing cognitive ability

Name of the tool	Authors, date(s), history of revisions	What it claims to measure	Method and by whom measured/ reported	No. of items and time taken	Subscales
Leiter International Performance Scale-Revised	Roid *et al.* (1997)[172] (Leiter-3 available, 2013)[262]	Measure of non-verbal intellectual functioning that consists of both perceptual and conceptual tasks designed to measure aspects of attention, cognition and memory	O; testing by clinicians, educators, researchers Blinding: Yes	691 items; 25–40 minutes Interval: NK	Two batteries: Visualisation and Reasoning Battery (VR) and Attention and Memory Battery (AM)
Mullen Scales of Early Learning	Mullen (1995)[163]	Measure cognitive ability and motor development quickly and reliably	O; testing by any professional who has experience and training in assessment practices Blinding: Yes	124 items; 25–35 minutes (3 years); 40–60 minutes (5 years) Interval: NK	Five subscales: Gross motor; Visual reception; Fine motor; Expressive language; Receptive language
Stanford–Binet Intelligence Scales-Fifth Edition	Roid (2003)[177]	Intellectual and cognitive abilities	O; testing by clinicians, educators, researchers Blinding: Yes	10 subtests, 5 minutes per subtest Interval: NK	Two domain scores: verbal IQ and non-verbal IQ Five factors: Fluid reasoning, Knowledge, Quantitative reasoning, Visual–spatial processing, Working memory

Interval, required interval between repeat administrations; NK, not known; O, direct observation.

Age range and entry criteria	Whether norms available, clinical cut-offs	Population for which designed	Cost/availability/languages	Training required
2 years to 20 years 11 months old	Norms available	General (individuals with hearing impairments, expressive or receptive language disorders, learning disabilities, cognitive impairment, traumatic brain injury, English as a second language, attentional problems, and ASDs)	Leiter-R Psychologists Kit US$925 English	Should be administered by a trained individual who has received supervised training and practice; it should be interpreted by someone with graduate training in psychological assessment
Birth to 68 months	Norms available	General	Mullen Scales of Early Learning – Complete Kit (record forms; test materials; manual; item administration book) US$849.65	Training in a relevant professional discipline; training in administration, scoring and interpretation of clinical assessments
2–85+ years old	Norms available	General	SB-5 Complete Test Kit & Interpretive Manual £1032 English	Training in a relevant professional discipline; training in administration, scoring and interpretation of clinical assessments

TABLE 31 Tools for assessing emotional regulation

Name of the tool	Authors, date(s), history of revisions	What it claims to measure	Method and by whom measured/reported	No. of items and time taken	Subscales
Baby and Infant Screen for Children with aUtIsm Traits-Part 2	Matson *et al.* (2009)[83]	Symptoms of other emotional difficulties found to commonly occur with ASD	Q; parents or caregivers Blinding: No	57 items Interval: NK	Five subscales: Tantrum/conduct behavior; Inattention/impulsivity; Avoidance behavior; Anxiety/repetitive behavior; Eating/sleep problem
Behavior Assessment System for Children-Second Edition, Parent Rating Scales	(see *Table 34*)				
Brief Infant–Toddler Social–Emotional Assessment	Briggs-Gowan and Carter (2002)[263]	Social–emotional/behavioural problems and delays in social–emotional competence	Q; parents and child-care providers Blinding: No	42 items Up to 10 minutes Interval: NK	Seven subscales: Internalising (eight items), Externalising (six items), Dysregulation (eight items), Competence (seven items), Social relatedness (three items), Maladaptive (three items), Atypical (four items); three additional scores
Child Behavior Checklist 1.5–5	(see *Table 33*)				
Child Behavior Checklist 6–18	(see *Table 33*)				
Children's Global Assessment Scale	Shaffer *et al.* (1983)[264]	Measure of overall severity of disturbance	S; clinicians Blinding: Yes	One rating (the lowest overall level of psychosocial functioning of the child or adolescent during the preceding month) Interval: 1 month	NA
Infant–Toddler Social–Emotional Assessment	Carter *et al.* (2003)[265]	A wide array of social–emotional and behavioural problems and competencies	Q; parents Blinding: No	166 items; 25–30 minutes Interval: NK	Four broad domains, 17 specific subscales, and three index scores[a]

Interval, required interval between repeat administrations; NA, not applicable; NK, not known; Q, questionnaire; S, scale.

a Domains: Externalising, Internalising, Dysregulation and Competencies. The Externalising domain is composed of Activity/impulsivity, Aggression/defiance and Peer aggression scales. The Internalising domain includes Depression/withdrawal, General anxiety, Separation distress and Inhibition to novelty scales. The Dysregulation domain includes Sleep, Negative emotionality, Eating and Sensory sensitivity scales. Competencies include Compliance, Attention, Imitation/play, Mastery motivation, Empathy and Prosocial peer relations scales. In addition, Maladaptive, Atypical behaviour and Social relatedness indices are included to assess more serious problems, which tend to have low base rates of occurrence.

Age range and entry criteria	Whether norms available, clinical cut-offs	Population for which designed	Cost/availability/languages	Training required
17–37 months	Cut-offs and norms available for infants with ASD, and those who have atypical development	ASD, and children with a non-ASD-related developmental delay	Available from Disability Consultants, LLC Kit (manual, protocols, score sheets) US$325 English	NA
12–36 months	Norms available	General	BITSEA Kit (manual, parent forms, childcare provider forms) US$116.00 English and Spanish	Training in a relevant professional discipline
4–16 years	NA	General	The CGAS is available online: www.rcpsych.ac.uk/docs/CGAS%20tool.doc www.rcpsych.ac.uk/pdf/CGAS%20Ratings%20Guide.pdf English	Training in a relevant professional discipline
12–36 months	Norms available	General	ITSEA Kit (parent forms, child-care provider forms, and manual) US$182.60 English and Spanish	Training in a relevant professional discipline; also requires a high level of expertise in test interpretation

TABLE 32 Tool for assessing play

Name of the tool	Authors, date(s), history of revisions	What it claims to measure	Method and by whom measured/ reported	No. of items and time taken	Subscales
Test of Pretend Play	Lewis and Boucher (1997)[202]	Symbolic play, conceptual development and use of symbols	O; testing by clinicians Blinding: Yes	Up to 45 minutes Interval: NK	Assessing three types of symbolic play: substituting one object for another object or person; attributing an imagined property to an object or person; reference to an absent object, person or substance

Interval, required interval between repeat administrations; NK, not known; O, direct observation including testing.

Age range and entry criteria	Whether norms available, clinical cut-offs	Population for which designed	Cost/availability/languages	Training required
1–6 years: Non-verbal version for children up to 3 years; verbal version for children over three years	Norms available (co-normed with the Preschool Language Scales-UK)	General	Available from Pearson English	Training in a relevant professional discipline

Behaviour problems

For details, see *Table 33*.

The CBCL has forms for children aged 1.5–5 years and 6–18 years, and this linkage across ages is a strength of the tool for longitudinal studies. The items can be scored on psychiatric scales, although this may not be as relevant for children with ASD up to the age of 6 years. It was used in three observational studies and three intervention evaluation studies in this review. Information on measurement properties is lacking in terms of reliability and sensitivity to change. The participants at the Discussion Day liked the clear instructions, with a time frame of 2 months, and the wide range of questions, including a qualitative section at the end enquiring about the best things about the child. The three-point scale may not provide sufficient range to capture change. The participants noted that the short questions do not establish the underlying reasons why a child might show the behaviours.

The following four behaviour scales have all been developed for individuals with disabilities.

The ABC only just overlaps with our target age group, and the content clearly derives from work with older individuals with intellectual impairments. It was used in four observational studies in our review, with children as young as 3 years. There is reasonably strong evidence for its measurement properties in children with ASD.

The BISCUIT-Part 3 is, by contrast, a short scale focused on infants up to 37 months of age. It was used in one observational study in our review, and the evidence for its structural validity was not strong.

The HSQ-PDD version is relatively new, and was used in one intervention evaluation study in our review. It originates from the Research Units on Pediatric Psychopharmacology Autism Network. The evidence for its measurement properties is strong, including responsiveness to change.

The NCBRF starts with 10 positive social items, before the 66 problem items. Parents are also invited to mention special circumstances that may have affected the child's behaviour in the last month. Participants at the Discussion Day particularly appreciated that the items included some which were relevant to ASD. However, participants thought some items were poorly worded (e.g. 'resisted provocation'), several were not relevant to children in the age range up to 6 years (including items such as 'feels worthless or inferior') and some items would be typical for a 3-year-old (e.g. 'runs away from adults'). The evidence on measurement properties was mixed. This tool was used in one intervention evaluation study in the review.

Global measure of functioning

For details, see *Table 34*.

The BASC-2 was not developed for the assessment of individuals with disabilities. It was used in one observational study in the review. The evidence on measurement properties was restricted to discriminating between groups.

Similarly the SIB-R is for the general population (birth to old age). It was used in one intervention evaluation study in this review. The evidence on measurement properties in children with ASD is limited.

The PEP-R and PEP-3 were specifically developed for assessment of children with autism. With an emphasis on identifying learning strengths, uneven development and emerging abilities, they are primarily intended to be useful in educational programming. They were used in four intervention evaluation studies and five observational studies in this review. The evidence on measurement properties (for the PEP-R) was reasonably strong.

The VABS are very widely used in ASD research and clinical practice, and cover birth to 90 years of age. In this review it was used in 67 studies, 24 of which were intervention evaluation. However, evidence from studies specifically on measurement properties in use with children with ASD was limited. Further evidence on the VABS Screener, developed for research purposes, would be useful though the reduced number of items might well restrict responsiveness to change.

Parent stress

For details, see *Table 35*.

The APSI lists 13 problem behaviours or areas of concern, and asks about the degree of stress created. Parents in the MeASURe advisory groups, and at the Discussion Day, considered that many of the behaviours listed would not cause stress, and, conversely, that important areas which do cause stress, such as dealing with service providers or taking the child out into the community, were not covered. Therefore, the scale might capture change only in specific areas after intervention. The APSI was used in one intervention evaluation study in the review, by the authors. More evidence is required about its measurement properties.

The PSI has a long history and was designed to assess the level of difficulties experienced by parents of children with behavioural and emotional problems, in particular those parents who are at risk of dysfunctional parenting. The one-page Short Form has a mixture of questions about the child and about parent feelings. Participants at the Discussion Day found the questions very negatively worded and wondered whether parents would be wary of being judged. They commented that aspects such as resilience, and having a support network, were important and not included. The PSI was used in eight intervention evaluation studies and three observational studies in the review. Evidence for its measurement properties in use with parents of children with ASD is relatively strong.

The QRS-F has wide use in the field of child disability. Parents at the advisory group meetings found it negative in wording and were uncomfortable with the yes/no scoring format. They considered this would also limit measurement of change. The QRS-F had been used in four intervention evaluation studies and three observational studies in the review. Evidence on measurement properties when used with parents of children with ASD was limited.

TABLE 33 Tools for assessing behaviour problems

Name of the tool	Authors, date(s), history of revisions	What it claims to measure	Method and by whom measured/reported	No. of items and time taken	Subscales
Aberrant Behavior Checklist	Aman *et al.* (1985)[266]	Originally designed to assess treatment effects in people with intellectual disabilities	Q; parents, caregivers or other individuals who know the child well Blinding: No	58 items 10–15 minutes Interval: NA	Five subscales: Irritability, agitation, crying (15 items); Lethargy/social withdrawal (16 items); Stereotypic behavior (seven items); Hyperactivity/non-compliance (16 items); Inappropriate speech (four items)
Baby and Infant Screen for Children with aUtIsm Traits-Part 3	Matson *et al.* (2009)[83]	Challenging behaviours that are common among infants and toddlers with ASD	Q; parents or caregivers Blinding: No	15 items Interval: NA	Three subscales: Aggressive/disruptive behaviors; Stereotypic behaviors; Self-injurious behavior
Behavior Assessment System for Children-Second Edition, Parent Rating Scales	(See *Table 34*)				
Child Behavior Checklist 1.5–5	Achenbach and Rescorla (2000)[184]	Specific behavioural, emotional and social problems that characterise preschool children	Q; parents, teachers Blinding: No/potential	99 items 10–20 minutes Interval: NA	*Syndrome scales*: Emotionally reactive; Anxious/depressed; Somatic complaints; Withdrawn; Sleep problems (CBCL only); Attention problems; Aggressive behavior *DSM-orientated scales*: Affective problems; Anxiety problems; Pervasive developmental problems; Attention deficit/hyperactivity problems; Oppositional defiant problems
Child Behavior Checklist 6–18	Achenbach (2001)[191]	Specific behavioural and emotional problems	Q; parents, caregivers or other individuals who know the child well Blinding: No/potential	118 items 15 minutes Interval: NA	Syndrome scales DSM-orientated scales
Home Situations Questionnaire-Pervasive Developmental Disorders version	Chowdhury *et al.* (2010)[209]	Assessing behavioural non-compliance in children	Q; caregivers Blinding: No	25 items Interval: NA	Two subscales: Socially inflexible, and Demand-specific

Age range and entry criteria	Whether norms available, clinical cut-offs	Population for which designed	Cost/availability/languages	Training required
6–54 years	Norms available	Individuals with mental retardation	Available in 40 languages Manual and residential and community forms/score Sheets (50) US$102	NA
17–37 months	Clinical cut-off scores available for moderate impairment and severe impairment	ASD and children with a non-ASD related developmental delay	Available from Disability Consultants, LLC Kit (manual, protocols, score sheets) US$325 English	NA
1.5–5 years	Norms available	General	Sample forms available online at www.aseba.org Ages 1.5–5 years hand-scoring starter kit (profiles, templates and manual) US$160 (computer scoring starter kit US$330) Available in nearly 100 languages	Training in a relevant professional discipline; knowledge of the theory and methodology of standardised assessment, as well as supervised training in working with the relevant kinds of clients
6–18 years	Norms available	General	Sample forms available online at www.aseba.org Computer scoring starter kit US$430 English, Spanish	(as above)
NK (source paper sample 4–13 years)	NK	Children with pervasive developmental disorders	From authors English	NA

continued

TABLE 33 Tools for assessing behaviour problems (*continued*)

Name of the tool	Authors, date(s), history of revisions	What it claims to measure	Method and by whom measured/ reported	No. of items and time taken	Subscales
Nisonger Child Behavior Rating Form (parent and teacher versions)	Aman *et al*. (1996)[198]	Assessment of child and adolescent behaviour	Q; parents or teachers Blinding: No/potential	76 items Interval: NA	Two domains: *Positive Social (10 items), subscales*: Compliant/ calm and Adaptive social *Problem Behavior (66 items); six subscales*: Conduct problem, Insecure/ anxious, Hyperactive, Self-injury/stereotypic, Self-Isolated/ritualistic, and Overly sensitive

Interval, required interval between repeat administrations; NA, not applicable; NK, not known; Q, questionnaire.

Age range and entry criteria	Whether norms available, clinical cut-offs	Population for which designed	Cost/availability/languages	Training required
3–16 years	NK	Children with developmental disabilities, namely those with intellectual disability and/or ASDs	Available online at: www.psychmed.osu.edu/ncbrf.htm	NA

TABLE 34 Tools for assessing global measure of functioning

Name of the tool	Authors, date(s), history of revisions	What it claims to measure	Method and by whom measured/ reported	No. of items and time taken	Subscales
Behavior Assessment System for Children-Second Edition, Parent and Teacher Rating Scales	Reynolds *et al.* (2004)[181]	Both adaptive and problem behaviours in the community and home setting	Q; completed by: parents/caregivers, teachers, clinicians Forms: The Teacher Rating Scales (TRS), Parent Rating Scales (PRS), Student Observation System (SOS) and Structured Developmental History (SDH) Blinding: No/potential	134–160 items (parent), 100–139 items (teacher), depending on age; 10–20 minutes Interval: NK	Nine clinical subscales: Aggression, Anxiety, Attention problems, Atypicality, Conduct problems, Depression, Hyperactivity, Somatization, Wthdrawal; five adaptive scales: Activities of Daily Living, Functional Communication, Adaptability, Leadership, Social Skills
Psychoeducational Profile-Revised[a]	Schopler *et al.* (1990)[214]	The developmental level of young children with autism	O; by therapists or psychologists Blinding: Yes	131 items, Developmental Scale; 43 items, Behavioural Scale 45–90 minutes Interval: NK	Seven developmental subscales; four behavioural subscales
Psychoeducational Profile-Third Edition	Schopler *et al.* (2005)[220]	The skills and behaviours of children with autism and communicative disabilities	O; by therapists or psychologists and Q (caregiver report, by parent/ caregiver) Blinding: Yes (and no)	45–90 minutes Interval: NK	Three composite scores: Communication, Motor and Maladaptive behaviors 10 performance subtests: Cognitive verbal/preverbal, Expressive language, Receptive language, Fine motor, Gross motor, Visual-motor imitation, Affective expression, Social reciprocity, Characteristic motor behaviors, Characteristic verbal behaviors
Scales of Independent Behaviour-Revised[b]	Bruininks *et al.* (1996)[224]	Adaptive behaviour and problem behaviour	O; direct assessment by clinicians Blinding: Yes	283 items 45–60 minutes for Full Scale; 15–20 minutes for Short Forms Interval: NK	14 Adaptive Behaviour subscales, Eight Problem Behaviour subscales

Age range and entry criteria	Whether norms available, clinical cut-offs	Population for which designed	Cost/availability/languages	Training required
Ages: 2 years to 21 years, 11 months (P and T)	Norms available	General	Forms and manuals from publisher BASC-2 Starter Kit US$125.50 English, Spanish	Professionals or paraprofessionals with formal graduate-level training or clinicians with training in psychological assessment
6 months to 7 years, but can be used for up to 12 years	Norms available	Children with autism or related developmental disorders	English	The PEP-R can be administered, scored and interpreted by anyone who has experience working with and testing children
6 months to 7 years	Norms available	Children with autism and communicative disabilities	Forms and manuals from publisher STAR Program: Strategies for Teaching Based on Autism Research Level III, Complete Kit US$345 With scoring software $588.00 English	The PEP-3 can be administered, scored and interpreted by anyone who has experience working with and testing children
Infants to 80+ years	Norms available	General	Forms and manuals from publisher Complete SIB-R Kit (interview book, manual, full scale, short form and early development response booklets) US$689.95 English	Training in a relevant professional discipline

continued

TABLE 34 Tools for assessing global measure of functioning (*continued*)

Name of the tool	Authors, date(s), history of revisions	What it claims to measure	Method and by whom measured/reported	No. of items and time taken	Subscales
Vineland Adaptive Behavior Scales: Survey Form; Classroom (VABS-II, 2005 available)	Sparrow *et al.* (1984)[167]	Personal and social sufficiency of individuals from birth to adulthood	I or Q; caregivers or teachers Blinding: potential	297 items, (SurveyForm); 244 items, (Classroom) 20–60 minutes Interval: NK	Five domains: Communication; Daily Living Skills; Socialisation; Motor Skills; Maladaptive Behavior
Vineland Adaptive Behavior Scales-Screener version	Sparrow *et al.* (1993)[54]	Assess for research purposes the personal and social sufficiency of individuals	I; child's primary caregiver Blinding: potential	45 items 15–20 minutes	Three domains: Communication, Daily Living Skills and Socialisation

I, interview; Interval, required interval between repeat administrations; NK, not known; O, direct observation including testing; Q, questionnaire.

a PEP-R: *Developmental subscales* – Imitation (16 items), Perception (13 items), Fine motor (16 items), Gross motor (18 items), Eye–hand co-ordination (15 items), Cognitive performance (26 items), Cognitive verbal (27 items); *Behavioural subscales* – Relating and affect (12 items), Play and interest in materials (eight items), Sensory responses (12 items), Language (11 items).

b SIB-R: *Adaptive Behaviour subscales* – Motor skills (Gross motor, Fine motor), Social interaction and communication skills (Social interaction, Language comprehension, Language expression), Personal living skills (Eating and meal preparation, Toileting, Dressing, Personal self-care, Domestic skills), Community living skills (Time and punctuality, Money and value, Home/community orientation); *Problem Behaviour subscales*: Hurtful to self, Unusual or repetitive habits, Hurtful to others, Socially offensive behaviour, Destructive to property, Withdrawal or inattentive behaviour, Disruptive behaviour, Unco-operative behaviour.

TABLE 35 Tools for assessing parent stress

Name of the tool	Authors, date(s), history of revisions	What it claims to measure	Method and by whom measured/reported	No. of items and time taken	Subscales
Autism Parenting Stress Index	Silva and Schalock (2012)[153]	Measure of parenting stress specific to core and comorbid symptoms of autism	Q; parents or caregivers Blinding: No	13 items; up to 5 minutes Interval: NA	Three categories: core autism symptoms, comorbid behaviours and comorbid physical issues
Parenting Stress Index-Short Form (Third Edition)	Abidin (1995)[228] (PSI-4 SF available, 2007)[268]	Parenting stress across a wide range of families and children, including those with ASD	Q; parents Blinding: No	36 items; 5 minutes Interval: NA	Three subscales: Parental distress; Parent–child dysfunctional interaction; Difficult child
Questionnaire on Resources and Stress-Friedrich Short Form	Friedrich *et al.* (1983)[231]	Level of stress in families of children with disabilities	Q; parents or caregivers Blinding: No	52 items	Four factors: parent and family problems; pessimism; child characteristics; physical incapacity

Interval, required interval between repeat administrations; NA, not applicable; NK, not known; Q, questionnaire.

Age range and entry criteria	Whether norms available, clinical cut-offs	Population for which designed	Cost/availability/languages	Training required
Birth to 18 years 11 months (Survey Form) 3 years to 12 years, 11 months (Classroom)	Norms available[267] (including supplementary norms for autism)	General	Vineland-II Complete Starter Kit (Survey, Expanded and Teacher Rating Forms, Manual) $420.65 English and Spanish	Training in a relevant professional discipline
Specific versions for – 2, 3–6, 6–12, 12–18 years	Norms available	Primarily developmentally disabled individuals	Forms and manuals are available from the publisher English	Training in a relevant professional discipline; 3–4 hours of specific training required

Age range and entry criteria	Whether norms available, clinical cut-offs	Population for which designed	Cost/availability/languages	Training required
Validation done on children aged 24–72 months old	NK	ASD	Available online: www.midss.org/content/autism-parenting-stress-index-apsi English	NA
1 month to 12 years	Norms and reference group profiles available	General	PSI Short Form Manual US$70 Questionnaire forms US$80 English, French	NA
To 18 years	Comparative data available	Children with disabilities	Child Psychology Portfolio[269] English	NA

Additional tools

There are several subdomains for which there is either a lack of tools, or a lack of evidence, about the use of such tools with young children on the autism spectrum. We will briefly consider some tools that may hold promise in future reviews, and also discuss some approaches to outcome measurement and monitoring of progress, which are overlooked by the systematic review process adopted in MeASURe.

Subdomains for which tools are lacking

In the Social awareness subdomain, evidence on measurement properties with children on the autism spectrum was limited. This is an example of when tools are likely to have been developed first with typically developing children. Examples include the ESCS[270] and the CSBS-DP.[125] In the recent review of social communication scales for use in medication trials in ASD,[238] both of these scales were rated 'appropriate with conditions' on the basis of evidence of reliability and of apparent sensitivity to change in ASD intervention studies. Nevertheless, both tools have ceiling effects, as they are appropriate up to ages equivalent to 30 months and 24 months, respectively, and both tools require detailed training and time for rating. Thus, the strategies adopted in the MeASURe review have not necessarily been overly exclusive.

A second subdomain to be discussed further is that of Habit Problems. Only two tools had been used in longitudinal or intervention studies in this review: subscales of the CBCL and the SSC. In addition, one study[271] had used sleep diaries. In the process of searching for papers on measurement properties of tools identified in *Chapter 3*, some new tools were found for which the paper had included tools searched for by name in establishing convergent validity (see *Appendix 9*). For example, the Children's Sleep Habits Questionnaire[272] is designed for children aged 4–12 years, and has been reviewed by Majnemer[29] for use with children with developmental disabilities. The Family Inventory of Sleep Habits for children with ASD[273] focuses on the particular problems of sleep anxiety and bedtime resistance. The Brief Autism Mealtime Behavior Inventory[274] is a tool recently developed specifically to assess eating problems in children with ASD. Thus future reviews should provide additional evidence regarding measurement tools in ASD for this important subdomain.

Domains of Participation and Family Measures are particularly under-represented in this review of tools. Although several Family tools had been used in studies in *Chapter 3*, no examination of their measurement properties in studies with children with ASD has been identified. This is a clear research gap. Similarly it would be desirable to have further exploration in ASD of tools related to social inclusion, such as the School Liking and Avoidance Questionnaire,[275] which can be teacher rated or self-reported by children as young as 3 years.[276]

Other approaches to measurement

The search for papers on measurement properties of tools has the effect of missing some approaches that have a legitimate place in monitoring the progress of young children with ASD. As mentioned in *Chapter 4*, the tool used most often in nurseries in UK is the Early Years Foundation Stage Profile. A number of other curriculum-based tools had been used in observational studies in the review. Such tools have the benefit of being closely related to programme planning for individual children. However, criterion-referenced assessment approaches are not usually examined in research for their measurement properties such as reliability and validity.

Other approaches that individualise assessment for children include 'Target Behaviours' and Goal Attainment Scaling. With the individuality of needs of young children with ASD, it may be particularly appropriate to adopt an idiographic approach to outcome measurement. Yet for the purposes of research, the ability to compare across individuals is required. A Target Behaviours (or target symptoms) methodology was included in the battery of tools recommended by the Research Units on Pediatric Psychopharmacology[277] and used by one study[278] in this review. When a specific behaviour is the target of intervention, the parent is interviewed about its nature, frequency and intensity, and a vignette description is prepared. At follow-up, the same questions are asked about the behaviour; the two vignettes are then compared and rated for degree of change on a nine-point scale by an expert panel. Thus this idiographic measure allows for 'blind' rating, and provides an opportunity to capture change. Inter-rater reliability across the expert panel can be assessed. Goal Attainment Scaling requires greater professional input (than Target Behaviours), including training and practice, to enable a suitable behavioural goal to be defined and scaled (with description of outcomes on a five-point scale between 'worst expected outcome' to 'best expected outcome'). There are continuing debates about appropriate statistical analyses of Goal Attainment Scaling scores, such as whether accomplishment of different individual goals can be summed into a group score. Nevertheless, if the Goal Attainment Scaling scores are done by observation, the assessor can be 'blind'.[279] These approaches to responsive measurement of relevant and individualised outcomes merit further exploration for young children with ASD.

In future, there will be a need to examine the measurement properties of biophysical tools, such as actigraphy and sleep recordings, i.e. of particular relevance to certain types of intervention, which have the apparent benefit of objectivity in measurement.

Finally, the review has not identified and evaluated tools used in economic analyses. Very little research has investigated the measurement of preference-based health-related quality-of-life outcomes in children with ASD.[280] Tools that have been examined for children with ASD include the Health Utilities Index Mark 3[280] and for parents the European Quality of Life-5 Dimensions three-level version.[281] These studies indicate promising findings on the measurement properties of the tools, but further research is required to establish whether they are appropriate for use in studies of children with ASD and how they may contribute to the evaluation of the cost-effectiveness of therapies and services.

How to choose a robust outcome tool

For a *researcher* wishing to choose a robust outcome tool, there are a series of complex decisions to negotiate. First there is the issue of what should be the primary goal of intervention – a focus on reducing particular ASD impairments or overall severity, improving child functional outcomes or quality of life for child and/or family? Each of these goals implies different conceptual and practical considerations, and different targeted outcomes reflecting the competing priorities. The second area for consideration has to do with external validity. The dilemma here is that subjective (particularly family reported) measures are those with the greatest external validity, as it is the experience of children and families that interventions most want to improve; however, such ratings are prone to expectation and placebo effects within interventions and such evidence is downgraded in systematic review criteria (such as Grading of Recommendations, Assessment, Development and Evaluation, and The Cochrane Collaboration). A final challenge concerns ideal measurement properties. The researcher would wish to identify outcome tools that are responsive to change and also appropriate across the different settings that children experience. Aggregated measures (e.g. combining parent and teacher report with direct observation of language skills) might increase stability and reduce correlated measurement error but are controversial. Responsiveness in tools may be limited in studies involving heterogeneous samples of children by floor and ceiling effects ('floor effects' when children have limited capacity to change; 'ceiling effects' when they have already mastered the skill). Furthermore, the review of measurement properties of tools in *Chapter 4* provided little evidence about measurement error or responsiveness to change.

For a *clinician or educator* wishing to monitor the progress of a child with ASD over time, in a nursery or other setting, there are other challenges. The tool has to have good face validity, making sense to all of those who will report on children's behaviours, and a high level of test–retest reliability so that clear judgements can be made about whether or not observed change really represents progress. It would ideally include the whole range of outcomes (strengths and difficulties) considered important by parents and staff involved with the child, and yet not take hours to complete.

In this chapter, the synthesis of evidence has demonstrated that we know more about some tools because they have been in use for longer. This is not necessarily a strength, where the models of understanding autism or child development which informed their development has changed. For all tools identified, there are areas of evidence lacking about their measurement properties. There are also many areas, identified as important by parents of children with autism, and by practitioners and researchers, for which tools are lacking. *Chapter 5* outlines recommendations for further research.

Thus, the following listing (*Table 36*) is not a battery of the 'best' tools; it is a summary of those 12 tools – identified through the MeASURe review process – that have more points in their favour than others. For inclusion in the table, the tools had positive evidence for three or more measurement properties, derived from more than one paper about its use with young children with ASD (see *Chapter 4*). When there was more than one similar tool within a subdomain meeting these criteria, the stronger was selected (e.g. the HSQ-PDD rather than the ABC, both tools measuring behaviour and developed in atypical populations). The level of burden (i.e. time, training, cost required) (see for example Lecavalier *et al.*[239]) is not considered in this summary, as its relevance will vary across the circumstances and purposes of both research and clinical practice; furthermore, direct assessment tools are the most expensive in time for training, but are those for which the assessor can be 'blind'.

TABLE 36 Summary of qualities of tools

Tool name *(subdomains)*	Intervention[a]	Blinding[b]	Stakeholder view	Age range[c]	Spread[d]
Autism Diagnostic Observation Schedule *(Symptom severity, Restricted/repetitive behaviour, Social communication, Social functioning)*	+	+	+	+	+
Baby and Infant Screen for Children with aUtIsm Traits-Part 2 *(Emotional regulation)*	–	–	NK	–	–
Behavioral Summarized Evaluation-Revised *(Symptom severity, Global measure of outcome)*	–	+	NK	+	–
Child Behavior Checklist *(Attention, Emotional regulation, Behaviour, Habit problems)*	+	–	+	+	+
Childhood Autism Rating Scale *(Symptom severity)*	+	?	NK	+	+
Home Situations Questionnaire-Pervasive Developmental Disorders version *(Behaviour)*	–	–	NK	–	–
MacArthur–Bates Communicative Development Inventory *(Language)*	+	–	NK	–	+
Parenting Stress Index *(Parent stress)*	+	–	–	+	+
Pervasive Developmental Disorders Behavior Inventory *(Global measure of outcome)*	+	–	–	+	+
Preschool Imitation and Praxis Scale *(Social awareness)*	–	+	NK	+	–
Psychoeducational Profile *(Global measure of function)*	+	+	NK	+	+
Social Responsiveness Scale *(Symptom severity)*	+	–	+	+	+

+, Yes; –, no; ?, unsure; NK, not known or not included in consultations (see *Chapter 5*).
a Was used in intervention studies in the review (see *Chapter 3*).
b Where parent knows the group allocation in a trial.
c Can be used across the 'up to 6 years' age range.
d Study in the review from more than one research group.

Chapter 6 Conclusions and recommendations

Introduction

The MeASURe project approach had significant strengths:

- MeASURe was delivered by a team of experts in systematic reviewing, working with health and education experts in the diagnosis, management and measurement of progress and outcomes in ASD.
- MeASURe used a systematic and multilayered approach to searching the literature.
- MeASURe used a validated approach to the assessment of the quality of papers concerning measurement properties of tools.
- The MeASURe group consulted with parents of children at three stages, with young people with ASD, and engaged with UK professionals through a survey and meetings.

This combination of procedures goes beyond the approaches used by other teams and individuals making recommendations of tools to use in measuring outcome in ASD.[27,234–236,238–240]

Reflections on consultation

The MeASURe project greatly benefited throughout from the involvement of parent advisory groups and individuals on the autism spectrum. To our knowledge, similar projects examining tools for outcome measurement in ASD have not included such investment in efforts for consultation and joint working with key stakeholders. Other stakeholders (health and education professionals, other researchers in ASD) were surveyed and involved in the Discussion Day.

As mentioned at the end of *Chapter 2*, the predominant focus of assessment tools on 'difficulties' rather than 'strengths' potentially misses some important features that would allow measurement of children's progress in acquisition of skills and capacity to adjust to their own profile of abilities, as well as key features for planning interventions. The tasks undertaken at the Discussion Day were illuminating: several professionals commented on the experience of focusing on up to six questionnaires one after another, with about 10 minutes for each one. They felt pressured and found their mood sinking after reading so many negative descriptions of child behaviour or parent stress. Further, the professionals reflected on what they may regularly expect parents to undertake during research projects or in clinical assessments, not realising the emotional challenge that such assessments involve. As one young adult on the autism spectrum involved in the MeASURe project commented further in an e-mail:

> *It occurred to me quite strongly that, while we tend to think of 'assessment' as being essentially a descriptive, documentary process, it is to an extent also transformative . . . This led me to think about the ethical considerations regarding the use of assessment for research, because unlike in a clinical, intervention-based environment, the aspect of reciprocity and 'what's in it for the parents/child' may not be quite so clear . . . I wonder whether it is considered and discussed with parents whether they consent to the possible transformative impact of taking part in assessments which . . . can be suggested to represent a pejorative deficit model of autism.*

This quote reminds professionals and researchers of the essential requirement to involve parents of young children with ASD in a meaningful partnership, with full discussion of what participation in an assessment involves (benefits as well as pressures), what it can convey and how it may be used. Attention should be paid to sharing the findings of assessment in an accessible format. These are important principles to be followed by health and education professionals, and by researchers.

Ideally, questionnaire-based tools to measure outcomes in ASD would include assessment of both skills and difficulties, contain a balance of positive and negative statements, and be attractive to look at (with an adequate font size and clear instructions) – qualities that we found many tools lacked. Nowadays, many individuals may prefer to complete questionnaires online rather than on paper, allowing much greater inclusion of visual enhancements. Most tools do not have electronic versions and have not been validated for this mode of administration. Other considerations about the process of direct clinical assessments were contributed by young people on the autism spectrum. These included the need for professionals to take time to get to know the child before assessment and to make sure that practical arrangements allow the child to take part to their best capacity.

Valued outcomes not represented

The dissonance between attention to the behaviours considered in the diagnostic process in autism, and the lack of focus on valued outcomes, was very evident in the MeASURe project as touched on above and in *Chapter 2*. The tools that were developed primarily to aid assessment and diagnosis have influenced also what we have called 'global measures of outcome', i.e. they include lists of symptoms that may or may not be amenable to change, and which may or may not be related to the focus of intervention. The emphasis may arise from the orientation of some research teams whose primary aim is to 'cure autism'. Some parents may indeed share such an aim, especially early on, around the time of the child's diagnosis. In contrast, parents and young people on the autism spectrum consulted in the MeASURe project focused on living with autism in daily life, on reducing stress and building up skills, and on enabling environments to be more 'autism friendly' and thus promote participation. Bringing these different perspectives – and valued outcomes – together would be likely to benefit children with ASD and their families, and is consistent with the recommendations of the Kennedy Report.[16] Some of the additional and relevant outcomes that were considered important to measure would thus include social interaction skills (e.g. with brothers, sisters and other children) and everyday adaptive skills, recognition of co-occurring problems (e.g. sleep, eating), well-being of the child and family quality of life. The review has revealed the paucity of tools with known measurement properties in these areas.

Limitations

The aim of the MeASURe project was to identify robust tools that might be recommended for use with children with ASD up to the age of 6 years, and the procedures were designed to that end. Because of this, the chosen procedures led to some limitations of the evidence. By searching for studies which had included a sample of children with ASD (or at least consideration of autism characteristics in children with neurodevelopmental disorders) we did not assess and report the measurement properties of tools when used with other samples; very many tools are first developed with samples of typically developing children. Therefore, we are not representing the full spread of information about the quality of some of the tools considered when used for other purposes. The process adopted also disadvantages recently developed tools, for which evidence of their measurement properties will accumulate in the future.

The review did not include papers about the translation of a tool into a language other than English, except where the paper did then focus on assessment of measurement properties of the tool. Language and cultural issues can affect how tools perform.[282] Therefore, the review does not provide information on how robust a tool may be if translated for use in the UK with a child whose home language is not English. The review has not commented on how appropriate some North American tools may be (or the changes which may be required) for use in the UK. As mentioned in *Chapter 5*, there are important types of measurement (e.g. curriculum based, idiographic) which are also not represented in the review because of the chosen procedures.

Outcomes of MeASURe

The detailed systematic reviews and consultation processes led to production of a conceptual framework for the measurement of outcomes in studies of children with ASD up to approximately 6 years of age (see *Chapter 2*). We expect this framework to be of use to researchers in the field of autism, and also to practitioners when considering how to monitor the richness of potential effects of their interventions.

The fifth aim of the MeASURe project was to propose a potential battery of robust tools and outcome measures for use in research and clinical practice. It would be particularly desirable to have such a battery used across intervention studies, to enable meta-analysis. However, in the course of the project, the unbalanced nature of the evidence has meant that we have decided to list only the 12 tools with more than a minimum of positive evidence about their measurement properties (see *Chapter 5*). This represents the current state of evidence but given the limitations, and the scope and overlap of the tools, the list cannot constitute a 'recommended battery'. Nevertheless, it gives guidance on some tools for which further study of measurement properties, and re-evaluation of presentation, would repay effort.

The limitations of what we know about the tools include in most instances no evidence about responsiveness to change. The COSMIN checklist did not require that a study should compare degree of change between points in time against a 'gold standard', which would be difficult to achieve in early autism studies when there is no such comparator; rather, it allowed for evidence to be obtained through statement of a priori directional hypotheses concerning expected change. Yet this has rarely been done to establish the measurement properties of an instrument (the development of the HSQ-PDD tool[209] being an exception in the list of 12 tools). Obviously, the extent to which significant treatment effects have been found in studies using such tools as part of their evaluation could add incidental backing to the weight of positive evidence in favour of using a tool. However, given the likely effects of publication bias, and difficulties in interpretation of negative findings (whether a reflection of an ineffective intervention or of an unresponsive tool), this is not a systematic source of information.

Improvement is also required in the design and procedures of studies concerning the measurement properties of tools. In particular, the limitations in the available evidence have restricted our capacity to comment on issues such as generalisability as most studies used clinic or convenience samples, were conducted in research rather than naturalistic settings, and did not take into account appropriateness across the range of ability in children with ASD.

Nevertheless, the review has provided a searchable source of evidence for researchers, and clinicians, on the qualities of many tools used with young children with ASD. Let us take a worked example. Both parents and professionals had 'challenging behaviour' as an important outcome in their top 10 constructs (see *Chapter 2*). What can we learn about the various possible tools? In *Appendix 5*, we can see that 12 different approaches to the measurement of behaviour problems were found, with information about the samples of children participating in those studies, the subscales used and the outcomes measured according to the study authors. Then in *Chapter 4*, we can inspect *Table 19* regarding Behaviour problems, where the evidence about papers reporting the measurement properties of tools is summarised. Here we find that evidence was found about only six of those tools in use with children with ASD. The detail of the findings from the individual papers can be viewed in *Appendix 8*. Let us say that a researcher is particularly concerned to choose a tool with positive evidence concerning structural validity in ASD. This review suggests three choices: the ABC, the CBCL and the HSQ-PDD. By inspection of *Table 33* in *Chapter 5*, the researcher learns that the ABC was not designed for the younger end of the age range, despite having been used in studies with children with ASD as young as 3 years. The HSQ-PDD is not yet freely available, therefore the researcher might choose the CBCL 1.5–5 years, reassured that stakeholders at the Discussion Day were generally positive about the scale.

As a further example, we might consider a research team wishing to evaluate a targeted intervention focusing on improving joint attention and imitation – core impairments in young children with autism.[283,284] Skills in joint attention and imitation are fundamental to the development of language and social development. For this reason, many recent early intervention studies have focused on enhancing these skills in the context of reciprocity between a child and familiar adult (parent or teacher).[285,286] What model of outcome measurement might be appropriate for a short-term intervention focusing on joint attention and imitation? Proximal measures will include direct observation and coding of adult–child interaction (see for example Kasari *et al.*[287] and Kaale *et al.*[288]). Focused measurement of joint engagement and joint attention may lend itself to standardisation in future, but could not be reviewed by MeASURe as the codes are adapted from study to study (see *Appendix 5*). Is there a more formal way to measure the broader subdomain of Social awareness? In *Table 3*, nine possible measures are listed; however, in *Table 8*, only two have supportive evidence on their measurement properties, and the stronger is the PIPS, included in the MeASURe list of 12 tools (see *Table 36*). The research team hypothesises that there will be a more distal intervention effect on Language; in *Table 3*, 17 measures are listed, including parent report of vocabulary and direct testing. They consult *Table 11* and find limited evidence for only two direct assessments in children with ASD (the MSEL and the PLS-4). This then requires a pragmatic decision about which to choose. Parent report of vocabulary (MCDI) has greater support, and is also included in the MeASURe list of 12 tools (see *Table 36*). The research team expects to find a broader effect on social communication; eight tools are listed in *Table 3* but only three have supportive evidence in *Table 16*. The ADI-R is a diagnostic interview, and so not suitable for short-term outcome measurement. The ADOS has strong properties (see *Table 24*) and the inclusion of the Toddler Module in ADOS-2 allows very young children to be assessed. However, it is again primarily a diagnostic tool and evidence on responsiveness to change is lacking. The Brief Observation of Social Communication Change (BOSCC), which originated as a development from the ADOS, may be an option in future having been developed explicitly for this purpose, allowing assessment blind to trial allocation (see *Chapter 5*). The SRS (see *Table 36*) would, in principle, allow parents to report on their children's skills and difficulties, but the total score covers multiple components, and, again, this tool lacks evidence on responsiveness to change (*Table 6*). Thus the MeASURe review allows a research team to make an informed though difficult choice of tools to address their model of outcome measurement.

Conclusions

A number of research gaps and suggestions have been highlighted in this report. In order for a battery of robust tools and outcome measures for use with young children with ASD to become a reality, the following points would need to be taken into consideration:

1. Prior to development of new tools it would be helpful for researchers to consult approaches to evaluation of the properties of tools, such as the freely available COSMIN approach (www.cosmin.nl) or the resources provided by the Patient Reported Outcomes Measurement Group at the University of Oxford (http://phi.uhce.ox.ac.uk/home.php). This would guide the design of the development studies so that all important properties are considered.
2. Critically, stakeholders and especially parents and individuals on the autism spectrum should be included from the start of development of new tools, to discuss the purpose of the tool, its content and presentation, and the likely impact on children and parents of the tool in use. The NIHR INVOLVE (www.involve.org.uk) provides a range of resources to advise on working in partnership with service users.
3. Tools should be developed and validated particularly in areas such as quality of life (child well-being) and participation in life situations (such as social inclusion) that were highly valued by parents and people with ASD. Consideration should be given to the content of tools, so that direct assessments are attractive to young children, and questionnaires include positively worded items and strengths as well as difficulties.

4. However, there are already multiple tools available and more being developed. More is not necessarily better. There were 75 tools for which no evidence was discovered for *Chapter 4*. Some of these tools could be suitable for further evaluation of their measurement properties with children with ASD, as an alternative to producing brand new tools measuring the same domain. Such studies should examine face and content validity, with input from parents of young children with ASD. The study design should evaluate measurement invariance across the range of abilities in ASD and across settings.
5. The list of 44 new tools found during the *Chapter 4* searches (see *Appendix 9*) have already been used with children with ASD, and so may also be examined further with reference to their measurement properties.
6. One urgent research priority is to establish a robust tool that can be measured 'blind', which captures social communication skills and is suitable across the age and ability range in children with ASD up to the age of 6 years. The BOSCC may prove to be such a tool, as mentioned in *Chapter 5*.
7. Measurement of RRBs is more problematic, as valid approaches to direct observation are essentially not possible after the first 1 or 2 years of life. A tool such as the ADOS does measure RRBs but only within a structured play setting, which may not elicit the behaviours that are characteristic of an individual child. Only one parent questionnaire had sufficient evidence about measurement properties to be included (see *Table 9*), so more development work is required on the most appropriate RRB measurement tools, which can be used across settings (such as home and nursery).
8. Questionnaire approaches to global measure of outcome have usually been hampered by covering a wide age and ability range (thus including items inappropriate for a young child) and focusing on (negatively worded) symptoms rather than skills. A new approach is needed, developed in partnership with parents and with individuals on the autism spectrum, to attempt to generate a useful and meaningful global measure of outcome and response to intervention for young children with ASD.
9. In addition to measurement of core ASD characteristics, the MeASURe project has highlighted the importance of also measuring children's functioning in everyday life. The VABS are the most extensively used tool for global measure of function, with surprisingly little evidence available about their measurement properties in use with young children with ASD. We therefore recommend that such studies be undertaken.
10. The MeASURe project did not include all of the procedures required to establish agreement on a core outcome set for young children with autism. The COMET Network suggests various procedures (www.comet-initiative.org/resources/coreresourcepack), which enable consensus to be reached, including rounds of consultation through Delphi surveys. Using levels of agreement on which suggested outcomes are deemed 'essential', with feedback to consultees at each round and a final consensus meeting of stakeholders, it is possible to refine a large number of possible outcomes into a core listing. Given the foundation established in the MeASURe project, these further procedures could be followed, ideally in conjunction with international partners, in order to create a consensus core outcome set.

Research recommendations in order of priority

1. Development of a tool to measure child quality of life, with careful attention to content validation for children with ASD.
2. Assessment of the measurement properties of a newly developed tool, the BOSCC, by research group(s) in the UK, as a potential primary outcome for early intervention trials focused on improving social communication in young children with ASD.
3. Assessment of the measurement properties of tools developed for children with ASD up to the age of 6 years, which focus on problems such as anxiety and sleep.
4. Further studies of the measurement properties of the VABS in young children with ASD.
5. Assessment of the measurement properties of the UK Early Years Foundation Stage Profile for use with young children with ASD.
6. Development of a questionnaire tool appropriate for young children with ASD to measure repetitive behaviour and circumscribed interests, which can be used across settings.
7. Establishment of an agreed core set of outcomes to be measured in effectiveness trials of early intervention in ASD.

Given the rapid developments in the field of research into young children with ASD, it would be appropriate to update the review of outcome measurement within 3 years.

Acknowledgements

The MeASURe project team are very grateful to the parents of children with ASD, and the children and adults on the autism spectrum, who participated at several points in the project. They provided important insights and experiences. We are also grateful to the hundreds of health and education professionals who completed the survey of assessment practice, and especially to those who participated in the Discussion Day. We are also grateful to the Mental Health Research Network North East, which funded aspects of the public participation work.

Gillian Loomes contributed rich and clear insights from her perspective as an autism advocate. Camilla McHugh contributed to the parent advisory groups and created *Figure 1*. Andrew Pickles read the first draft of the report and made invaluable comments. Jane Tilbrook was the very able administrator for the project, and tireless in her battle with EndNote. We are grateful to all of these experts.

We are grateful also for the additional financial support for this project provided by the Research and Development Division of the Public Health Agency, Northern Ireland.

Contributions of authors

Helen McConachie (Professor, Clinical Psychology) led the design of the project; participated in all stages of review of the project; led aspects of consultation with stakeholders; conducted sifting and data extraction; supervised data extraction; wrote sections of the report; and finalised the report.

Jeremy R Parr (Senior Lecturer, Paediatric Neurodisability) contributed to the design of the project; participated in all stages of review of the project; led aspects of consultation with stakeholders; wrote sections of the report; created the scientific summary; and commented in detail on drafts.

Magdalena Glod (Research Assistant, Psychology) conducted sifting and data extraction; wrote sections of the report; and created tables.

Jennifer Hanratty (Research Fellow, Systematic Reviews) conducted sifting and data extraction; wrote sections of the report; and created detailed appendices and tables.

Nuala Livingstone (Research Fellow, Systematic Reviews) contributed to the design of the project; participated in all stages of review of the project; conducted the scoping review of qualitative literature; conducted sifting and data extraction; wrote sections of the report; and created tables and figures.

Inalegwu P Oono (Research Assistant, Systematic Reviews) conducted sifting and data extraction, and created tables.

Shannon Robalino (Information Specialist, Health Research) created the systematic searches and wrote sections of the report.

Gillian Baird (Professor, Paediatric Neurodisability) contributed to the design of the project and commented in detail on drafts.

Bryony Beresford (Professor, Social Policy) contributed to the design of the project; conducted the scoping review of qualitative literature; and wrote sections of the report.

Tony Charman (Professor, Clinical Psychology) contributed to the design of the project; participated in all stages of review of the project; commented in detail on drafts.

Deborah Garland (Parent, Resource Centre Manager) contributed to the design of the project; participated in all stages of review of the project; led aspects of consultation with stakeholders; and contributed to the Plain English summary.

Jonathan Green (Professor, Child and Adolescent Psychiatry) contributed to the design of the project and commented in detail on drafts.

Paul Gringras (Professor, Paediatric Neurodisability) contributed to the design of the project and led aspects of consultation with stakeholders.

Glenys Jones (Lecturer, Education) contributed to the design of the project; participated in all stages of review of the project; led aspects of consultation with stakeholders; and commented in detail on drafts.

James Law (Professor, Speech and Language Therapy) contributed to the design of the project and commented in detail on drafts.

Ann S Le Couteur (Professor, Child and Adolescent Psychiatry) contributed to the design of the project; participated in all stages of review of the project; led aspects of consultation with stakeholders; and commented in detail on drafts.

Geraldine Macdonald (Professor, Child Care Research) contributed to the design of the project; participated in all stages of review of the project; supervised data extraction; and wrote the Plain English summary.

Elaine M McColl (Professor, Health Services Research) contributed to the design of the project and commented in detail on drafts.

Christopher Morris (Senior Research Fellow, Child Health) contributed to the design of the project; participated in all stages of review of the project; led aspects of consultation with stakeholders; conducted the scoping review of qualitative literature; wrote sections of the report; contributed to the Plain English summary; and commented in detail on drafts.

Jacqueline Rodgers (Senior Lecturer, Psychology) contributed to the design of the project; participated in all stages of review of the project; supervised data extraction; and commented in detail on drafts.

Emily Simonoff (Professor, Child and Adolescent Psychiatry) contributed to the design of the project; participated in all stages of review of the project; and commented in detail on drafts.

Caroline B Terwee (Assistant Professor, Clinimetrics) contributed to the design of the project; participated in all stages of review of the project; helped to create the systematic searches; and commented in detail on drafts.

Katrina Williams (Professor, Paediatric Neurodisability) contributed to the design of the project and commented in detail on drafts.

References

1. American Psychiatric Association (APA). *DSM-5 Development. DSM-5 Implementation and Support*. URL: www.dsm5.org/Pages/Default.aspx.DSM-V (accessed 2 March 2015).
2. Baird G, Simonoff E, Pickles A, Chandler S, Loucas T, Meldrum D, *et al.* Prevalence of the disorders of the autism spectrum in a population cohort of children in South Thames. *Lancet* 2006;**368**:210–15. http://dx.doi.org/10.1016/S0140-6736(06)69041-7
3. Baron-Cohen S, Allison C, Williams J, Matthews FE, Brayne C. Prevalence of autism-spectrum conditions: UK school-based population study. *Br J Psychiatry* 2009;**194**:500–9. http://dx.doi.org/10.1192/bjp.bp.108.059345
4. Brugha TS, McManus S, Bankart J, Scott F, Purdon S, Smith J, *et al.* Epidemiology of autism spectrum disorders in adults in the community in England. *Arch Gen Psychiatry* 2011;**68**:459–65. http://dx.doi.org/10.1001/archgenpsychiatry.2011.38
5. Knapp M, Romeo R, Beecham J. Economic cost of autism in the UK. *Autism* 2009;**13**:317–36. http://dx.doi.org/10.1177/1362361309104246
6. Charman T. Glass half full or half empty? Testing social communication interventions for young children with autism. *J Child Psychol Psychiatry* 2011;**52**:22–3. http://dx.doi.org/10.1111/j.1469-7610.2010.02359.x
7. Oono IP, Honey E, McConachie H. Parent-mediated early intervention for young children with autism spectrum disorders (ASD). *Cochrane Database Syst Rev* 2013;**4**:CD009774. http://dx.doi.org/10.1002/ebch.1952
8. Ospina MB, Seida JK, Clark B, Karkhaneh M, Hartling L, Tjosvold L, *et al.* Behavioural and developmental interventions for autism spectrum disorder: a clinical systematic review. *PLOS ONE* 2008;**3**:e3755. http://dx.doi.org/10.1371/journal.pone.0003755
9. Maskey M, Warnell F, Parr JR, McConachie H. Emotional and behavioural problems in children with Autism Spectrum Disorder. *J Autism Dev Disord* 2012;**43**:851–9. http://dx.doi.org/10.1007/s10803-012-1622-9
10. Charman T, Taylor E, Cockerill H, Brown JA, Baird G. Outcome at 7 years of children diagnosed with autism at age 2: predictive validity of assessments conducted at 2 and 3 years of age and pattern of symptom change over time. *J Child Psychol Psychiatry* 2005;**46**:500–13. http://dx.doi.org/10.1111/j.1469-7610.2004.00377.x
11. Anderson DK, Lord C, Risi S, DiLavore PS, Shulman C, Thurm A, *et al.* Patterns of growth in verbal abilities among children with autism spectrum disorder. *J Consult Clin Psychol* 2007;**75**:594–604. http://dx.doi.org/10.1037/0022-006X.75.4.594
12. Jones EJH, Gilga T, Bedford R, Charman T, Johnson MH. Developmental pathways to autism: a review of prospective studies of infants at risk. *Neurosci Biobehav Rev* 2014;**39**:1–33. http://dx.doi.org/10.1016/j.neubiorev.2013.12.001
13. Fein D, Barton M, Eigsti I-M, Kelley E, Naigles L, Schultz R, *et al.* Optimal outcome in individuals with a history of autism. *J Child Psychol Psychiatry* 2013;**54**:195–205. http://dx.doi.org/10.1111/jcpp.12037
14. Department of Health (DH). *Annual Report of the Chief Medical Officer 2012: Our Children Deserve Better: Prevention Pays*. London: DH; 2012.

15. Department of Health (DH). *The NHS Outcomes Framework 2011/12*. 2010. URL: www.gov.uk/government/uploads/system/uploads/attachment_data/file/213789/dh_123138.pdf (accessed 2 March 2015).

16. Kennedy I. *Getting it Right for Children and Young People: Overcoming Cultural Barriers in the NHS so as to Meet Their Needs*. London: Department of Health; 2010.

17. Morris C, Janssens A, Allard A, Thompson-Coon J, Shillling V, Tomlinson R, *et al.* Informing the NHS Outcomes Framework: evaluating meaningful health outcomes for children with neurodisability using multiple methods including systematic review, qualitative research, Delphi survey and consensus meeting. *Health Serv Deliv Res* 2014;**2**(15).

18. Williamson PR, Altman DG, Blazeby JM, Clarke M, Devane D, Gargon E, *et al.* Developing core outcome sets for clinical trials: issues to consider. *Trials* 2012;**13**:132. http://dx.doi.org/10.1186/1745-6215-13-132

19. Sinha I, Smyth RL, Williamson PR. A systematic review of studies that aim to determine which outcomes to measure in clinical trials in children. *PLOS Med* 2008;**5**:e96. http://dx.doi.org/10.1371/journal.pmed.0050096

20. World Health Organization (WHO). *International Classification of Functioning, Disability and Health for Children and Youth*. Geneva: WHO; 2007.

21. Lai M-C, Lombardo MV, Baron-Cohen S. Autism. *Lancet* 2014;**383**:896–910. http://dx.doi.org/10.1016/S0140-6736(13)61539-1

22. Jeans LM, Santos RM, Laxman DJ, McBride BA, Dyer WJ. Early predictors of ASD in young children using a nationally representative data set. *J Early Interv* 2014;**35**:303–31. http://dx.doi.org/10.1177/1053815114523319

23. Zwaigenbaum L, Bryson S, Rogers T, Roberts W, Brian J, Szatmari P. Behavioral manifestations of autism in the first year of life. *Int J Dev Neurosci* 2005;**23**:143–52. http://dx.doi.org/10.1016/j.ijdevneu.2004.05.001

24. Zwaigenbaum L, Bryson S, Lord C, Rogers S, Carter AS, Carver L, *et al.* Clinical assessment and management of toddlers with suspected autism spectrum disorder: insights from studies of high-risk infants. *Pediatrics* 2009;**123**:1383–91. http://dx.doi.org/10.1542/peds.2008-1606

25. Gilmour J, Hill B, Place M, Skuse DH. Social communication deficits in conduct disorder: a clinical and community survey. *J Child Psychol Psychiatry* 2004;**45**:967–78. http://dx.doi.org/10.1111/j.1469-7610.2004.t01-1-00289.x

26. Ketelaars MP, Cuperus J, Jansonius K, Verhoeven L. Pragmatic language impairment and associated behavioural problems. *Int J Lang Commun Disord* 2009;**28**:1–17. http://dx.doi.org/10.1080/13682820902863090

27. Bolte EE, Diehl JJ. Measurement tools and target symptoms/skills used to assess treatment response for individuals with autism spectrum disorder. *J Autism Dev Disord* 2013;**43**:2491–501. http://dx.doi.org/10.1007/s10803-013-1798-7

28. Wittemeyer K, Charman T, Cusack J, Guldberg K, Hastings R, Howlin P, *et al. Educational Provision and Outcomes for People on the Autism Spectrum*. London: Autism Education Trust; 2013.

29. Majnemer A. *Measures for Children with Developmental Disabilities: An ICF-CY Approach*. London: Mac Keith Press; 2012.

30. Wilson IB, Cleary PD. Linking clinical variables with health-related quality of life. *J Am Med Assoc* 1995;**273**:59–65. http://dx.doi.org/10.1001/jama.1995.03520250075037

31. Auert E, Trembath D, Arciuli J, Thomas D. Parents' expectations, awareness, and experiences of accessing evidence-based speech-language pathology services for their children with autism. *Int J Speech Lang Pathol* 2012;**14**:109–18. http://dx.doi.org/10.3109/17549507.2011.652673

32. Braiden H, Bothwell J, Duffy J. Parents' experience of the diagnostic process for autistic spectrum disorders. *Child Care Pract* 2010;**16**:377–89. http://dx.doi.org/10.1080/13575279.2010.498415

33. Whitaker P. Supporting families of preschool children with autism: what parents want and what helps. *Autism* 2002;**6**:411–26. http://dx.doi.org/10.1177/1362361302006004007

34. Beresford B, Tozer R, Rabiee P, Sloper P. Desired outcomes for children and adolescents with Autistic Spectrum Disorders. *Child Soc* 2006;**21**:4–16. http://dx.doi.org/10.1111/j.1099-0860.2006.00008.x

35. Serpentine EC, Tarnai B, Drager KDR, Finke EH. Decision making of parents of children with autism spectrum disorder concerning augmentative and alternative communication in Hungary. *Commun Disord Q* 2011;**32**:221–31. http://dx.doi.org/10.1177/1525740109353938

36. Mackintosh VH, GoinKochel RP, Myers BJ. 'What do you like/dislike about the treatments you're currently using?': a qualitative study of parents of children with autism spectrum disorders. *Focus Autism Other Dev Disabil* 2012;**27**:51–60. http://dx.doi.org/10.1177/1088357611423542

37. Little L, Clark RR. Wonders and worries of parenting a child with Asperger syndrome and nonverbal learning disorder. *MCN Am J Matern Child Nurs* 2006;**31**:39–44. http://dx.doi.org/10.1097/00005721-200601000-00009

38. McHugh C, Bailey S, Shilling V, Morris C. Meeting the information needs of children with chronic health conditions. *Phys Occup Ther Pediatr* 2013;**33**:265–70. http://dx.doi.org/10.3109/01942638.2013.799628

39. Nye C, Brice A. Combined vitamin B_6-magnesium treatment in autism spectrum disorder. *Cochrane Database Syst Rev* 2005;**4**:CD003497. http://dx.doi.org/10.1002/14651858.CD003497.pub2

40. Williams K, Wheeler DM, Silove N, Hazell P. Selective serotonin reuptake inhibitors (SSRIs) for Autism Spectrum Disorders (ASD). *Cochrane Database Syst Rev* 2010;**8**:CD004677. http://dx.doi.org/10.1002/14651858.CD004677.pub2

41. Wheeler D, Williams K, Seida J, Ospina M. The Cochrane Library and Autism Spectrum Disorder: an overview of reviews. *Evid Based Child Health* 2008;**3**:3–15. http://dx.doi.org/10.1002/ebch.218

42. Williams TO, Jr, Eaves RC. Factor Analysis of the Pervasive Developmental Disorders Rating Scale with teacher ratings of students with autistic disorder. *Psychol Sch* 2005;**42**:207–16. http://dx.doi.org/10.1002/pits.20051

43. Diggle TJ, McConachie HR, Randle VR. Parent-mediated early intervention for young children with Autism Spectrum Disorder. *Cochrane Database Syst Rev* 2003;**1**:CD003496.

44. Gold C, Wigram T, Elefant C. Music therapy for autistic spectrum disorder. *Cochrane Database Syst Rev* 2006;**2**:CD004381. http://dx.doi.org/10.1002/14651858.CD004381.pub2

45. Mulloy A, Lang R, O'Reilly M, Sigafoos J, Lancioni G, Rispoli M. Gluten-free and casein-free diets in the treatment of autism spectrum disorders: a systematic review. *Res Autism Spectr Disord* 2010;**4**:328–39. http://dx.doi.org/10.1016/j.rasd.2009.10.008

46. Elchaar GM, Maisch NM, Augusto LM, Wehring HJ. Efficacy and safety of naltexone use in pediatric patients with autistic disorder. *Ann Pharmacother* 2006;**40**:1086–95. http://dx.doi.org/10.1345/aph.1G499

47. Reichow B, Wolery M. Comprehensive synthesis of early intensive behavioral interventions for young children with autism based on the UCLA young autism project model. *J Autism Dev Disord* 2009;**39**:23–41. http://dx.doi.org/10.1007/s10803-008-0596-0

48. American Psychiatric Association (APA). *Diagnostic and Statistical Manual of Mental Disorders*. Washington: APA; 1994.

49. World Health Organization (WHO). *The ICD-10 Classification of Mental and Behavioural Disorders: Diagnostic Criteria for Research*. Geneva: WHO; 1992.

50. Lord C, Risi S, Lambrecht L, Cook EH Jr, Leventhal BL, DiLavore PC, *et al.* The Autism Diagnostic Observation Schedule-Generic: a standard measure of social and communication deficits associated with the spectrum of autism. *J Autism Dev Disord* 2000;**30**:205–23. http://dx.doi.org/10.1023/A:1005592401947

51. Siller M, Sigman M. The behaviors of parents of children with autism predict the subsequent development of their children's communication. *J Autism Dev Disord* 2002;**32**:77–89. http://dx.doi.org/10.1023/A:1014884404276

52. Siller M, Sigman M. Modeling longitudinal change in the language abilities of children with autism: parent behaviors and child characteristics as predictors of change. *Dev Psychol* 2008;**44**:1691–704. http://dx.doi.org/10.1037/a0013771

53. Rutter M, Le Couteur A, Lord C. *ADI-R: Autism Diagnostic Interview – Revised Manual*. Los Angeles, CA: Western Psychological Services; 2003.

54. Sparrow SS, Carter AS, Cicchetti DV. *Vineland Screener: Overview, Reliability, Validity, Administration and Scoring*. New Haven, CT: Yale University Child Study Center; 1993.

55. Leyfer OT, Folstein SE, Bacalman S, Davis NO, Dinh E, Morgan J, *et al.* Comorbid psychiatric disorders in children with autism: interview development and rates of disorders. *J Autism Dev Disord* 2006;**36**:849–61. http://dx.doi.org/10.1007/s10803-006-0123-0

56. Terwee CB, Jansma EP, Riphagen II, de Vet HCW. Development of a methodological PubMed search filter for finding studies on measurement properties of measurement instruments. *Qual Life Res* 2009;**18**:1115–23. http://dx.doi.org/10.1007/s11136-009-9528-5

57. Terwee CB, Bot SD, de Boer MR, van der Windt DA, Knol DL, Dekker J, *et al.* Quality criteria were proposed for measurement properties of health status questionnaires. *J Clin Epidemiol* 2007;**60**:34–42. http://dx.doi.org/10.1016/j.jclinepi.2006.03.012

58. Krug D, Arick J, Almond P. Behavior checklist for identifying severely handicapped individuals with high levels of autistic behavior. *J Child Psychol Psychiatry* 1980;**21**:221–9. http://dx.doi.org/10.1111/j.1469-7610.1980.tb01797.x

59. Krug DA, Arick JR, Almond PJ. *Autism Screening Instrument for Educational Planning. Examiner's Manual*. Portland, OR: ASIEP Education Company; 1980.

60. Sponheim E, Spurkland I. Diagnosing childhood autism in clinical practice: an inter-rater reliability study of ICD-10, DSM-III-R, Childhood Autism Rating Scale, and Autism Behavior Checklist. *Nord J Psychiatry* 1996;**50**:5–9. http://dx.doi.org/10.3109/08039489609081381

61. Sturmey P, Matson JL, Sevin JA. Analysis of the internal consistency of three autism scales. *J Autism Dev Disord* 1992;**22**:321–8. http://dx.doi.org/10.1007/BF01058159

62. Miranda-Linné FM, Melin L. A factor analytic study of the Autism Behavior Checklist. *J Autism Dev Disord* 2002;**32**:181–8. http://dx.doi.org/10.1023/A:1015519413133

63. Lord C, Rutter M, Le Couteur A. Autism Diagnostic Interview-Revised: a revised version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. *J Autism Dev Disord* 1994;**24**:659–85. http://dx.doi.org/10.1007/BF02172145

64. Lecavalier L, Aman MG, Scahill L, McDougle CJ, McCracken JT, Vitiello B, *et al.* Validity of the Autism Diagnostic Interview-Revised. *Am J Ment Retard* 2006;**111**:199–215. http://dx.doi.org/10.1352/0895-8017(2006)111[199:VOTADI]2.0.CO;2

65. Lord C, Risi S, DiLavore PS, Shulman C, Thurm A, Pickles A. Autism from 2 to 9 years of age. *Arch Gen Psychiatry* 2006;**63**:694–701. http://dx.doi.org/10.1001/archpsyc.63.6.694

66. Tadevosyan-Leyfer O, Dowd M, Mankoski R, Winklosky B, Putnam S, McGrath L, *et al.* A principal components analysis of the Autism Diagnostic Interview-Revised. *J Am Acad Child Adolesc Psychiatry* 2003;**42**:864–72. http://dx.doi.org/10.1097/01.CHI.0000046870.56865.90

67. Frazier TW, Youngstrom EA, Kubu CS, Sinclair L, Rezai A. Exploratory and confirmatory factor analysis of the autism diagnostic interview-revised. *J Autism Dev Disord* 2008;**38**:474–80. http://dx.doi.org/10.1007/s10803-007-0415-z

68. Snow AV, Lecavalier L, Houts C. The structure of the Autism Diagnostic Interview-Revised: diagnostic and phenotypic implications. *J Child Psychol Psychiatry* 2009;**50**:734–42. http://dx.doi.org/10.1111/j.1469-7610.2008.02018.x

69. Tsuchiya KJ, Matsumoto K, Yagi A, Inada N, Kuroda M, Inokuchi E, *et al.* Reliability and validity of autism diagnostic interview-revised, Japanese version. *J Autism Dev Disord* 2013;**43**:643–62. http://dx.doi.org/10.1007/s10803-012-1606-9

70. Chawarska K, Klin A, Paul R, Volkmar F. Autism spectrum disorder in the second year: stability and change in syndrome expression. *J Child Psychol Psychiatry* 2007;**48**:128–38. http://dx.doi.org/10.1111/j.1469-7610.2006.01685.x

71. Moss J, Magiati I, Charman T, Howlin P. Stability of the autism diagnostic interview-revised from pre-school to elementary school age in children with autism spectrum disorders. *J Autism Dev Disord* 2008;**38**:1081–91. http://dx.doi.org/10.1007/s10803-007-0487-9

72. Kamp-Becker I, Ghahreman M, Smidt J, Remschmidt H. Dimensional structure of the autism phenotype: relations between early development and current presentation. *J Autism Dev Disord* 2009;**39**:557–71. http://dx.doi.org/10.1007/s10803-008-0656-5

73. Norris M, Lecavalier L, Edwards MC. The structure of autism symptoms as measured by the autism diagnostic observation schedule. *J Autism Dev Disord* 2012;**42**:1075–86. http://dx.doi.org/10.1007/s10803-011-1348-0

74. Gray KM, Tonge BJ, Sweeney DJ, Einfeld SL. Screening for autism in young children with developmental delay: an evaluation of the developmental behaviour checklist: early screen. *J Autism Dev Disord* 2008;**38**:1003–10. http://dx.doi.org/10.1007/s10803-007-0473-2

75. Ben Itzchak E, Zachor DA. Change in autism classification with early intervention: predictors and outcomes. *Res Autism Spect Disord* 2009;**3**:967–76. http://dx.doi.org/10.1016/j.rasd.2009.05.001

76. Luyster R, Gotham K, Guthrie W, Coffing M, Petrak R, Pierce K, *et al.* The autism diagnostic observation schedule – toddler module: a new module of a standardized diagnostic measure for autism spectrum disorders. *J Autism Dev Disord* 2009;**39**:1305–20. http://dx.doi.org/10.1007/s10803-009-0746-z

77. Gotham K, Pickles A, Lord C. Standardizing ADOS scores for a measure of severity in autism spectrum disorders. *J Autism Dev Disord* 2009;**39**:693–705. http://dx.doi.org/10.1007/s10803-008-0674-3

78. De Bildt A, Oosterling IJ, van Lang ND, Sytema S, Minderaa RB, van Engeland H, *et al.* Standardized ADOS scores: measuring severity of autism spectrum disorders in a Dutch sample. *J Autism Dev Disord* 2011;**41**:311–19. http://dx.doi.org/10.1007/s10803-010-1057-0

79. Shumway S, Farmer C, Thurm A, Joseph L, Black D, Golden C. The ADOS calibrated severity score: relationship to phenotypic variables and stability over time. *Autism Res* 2012;**5**:267–76. http://dx.doi.org/10.1002/aur.1238

80. Bryson SE, McDermott C, Rombough V, Brian J, Zwaigenbaum L. *The Autism Observation Scale for Infants*. New York: Basic Books; 2000.

81. Bryson SE, Zwaigenbaum L, McDermott C, Rombough V, Brian J. The Autism Observation Scale for Infants: scale development and reliability data. *J Autism Dev Disord* 2008;**38**:731–8. http://dx.doi.org/10.1007/s10803-007-0440-y

82. Georgiades S, Szatmari P, Zwaigenbaum L, Bryson S, Brian J, Roberts W, *et al.* A prospective study of autistic-like traits in unaffected siblings of probands with autism spectrum disorder. *JAMA psychiatry* 2013;**70**:42–8. http://dx.doi.org/10.1001/2013.jamapsychiatry.1

83. Matson JL, Wilkins J, Sevin JA, Knight C, Boisjoli JA, Sharp B. Reliability and item content of the baby and infant screen for children with aUtIsm traits (BISCUIT): Parts 1–3. *Res Autism Spect Disord* 2009;**3**:336–44. http://dx.doi.org/10.1016/j.rasd.2008.08.001

84. Matson JL, Boisjoli JA, Hess JA, Wilkins J. Factor structure and diagnostic fidelity of the Baby and Infant Screen for Children with aUtIsm Traits-Part 1 (BISCUIT-part 1). *Dev Neurorehabil* 2010;**13**:72–9. http://dx.doi.org/10.3109/17518420903213576

85. Matson JL, Wilkins J, Fodstad JC. The validity of the Baby and Infant Screen for Children with aUtIsm Traits: Part 1 (BISCUIT: Part 1). *J Autism Dev Disord* 2011;**41**:1139–46. http://dx.doi.org/10.1007/s10803-010-0973-3

86. Barthelemy C, Adrien J, Tanguay P, Garreau B, Fermanian J, Roux S, *et al.* The Behavioral Summarized Evaluation: validity and reliability of a scale for the assessment of autistic behaviors. *J Autism Dev Disord* 1990;**20**:189–204. http://dx.doi.org/10.1007/BF02284718

87. Barthelemy C, Roux S, Adrien JL, Hameury L, Guerin P, Garreau B. Validation of the revised behavioral summarized evaluation scale. *J Autism Dev Disord* 1997;**27**:139–53. http://dx.doi.org/10.1023/A:1025887723360

88. Oneal BJ, Reeb RN, Korte JR, Butter EJ. Assessment of home-based behavior modification programs for autistic children: reliability and validity of the behavioral summarized evaluation. *J Prev Interv Community* 2006;**32**:25–39. http://dx.doi.org/10.1300/J005v32n01_03

89. Roux S, Malvy J, Bruneau N, Garreau B, Guerin P, Sauvage D, *et al.* Identification of behaviour profiles with a population of autistic children using multivariate statistical methods. *Eur Child Adolesc Psychiatry* 1995;**4**:249–58. http://dx.doi.org/10.1007/BF01980489

90. Adrien JL, Barthelemy C, Perrot A, Roux S, Lenoir P, Hameury L, *et al.* The Infant Behavioral Summarized Evaluation (I.B.S.E.). A rating scale for the assessment of young children with autism and developmental disorders. Validity and reliability. *J Autism Dev Disord* 1992;**22**:375–94. http://dx.doi.org/10.1007/BF01048241

91. Schopler E, Reichler RJ, DeVellis RF, Daly K. Toward objective classification of childhood autism: Childhood Autism Rating Scale (CARS). *J Autism Dev Disord* 1980;**10**:91–103. http://dx.doi.org/10.1007/BF02408436

92. Schopler E, Reichler J, Renner B. *The Childhood Autism Rating Scale (C.A.R.S.)*. Los Angeles, CA: Western Psychological Services; 1988.

93. Russell PS, Daniel A, Russell S, Mammen P, Abel JS, Raj LE, *et al.* Diagnostic accuracy, reliability and validity of Childhood Autism Rating Scale in India. *World J Pediatr* 2010;**6**:141–7. http://dx.doi.org/10.1007/s12519-010-0029-y

94. Magyar CI, Pandolfi V. Factor structure evaluation of the childhood autism rating scale. *J Autism Dev Disord* 2007;**37**:1787–94. http://dx.doi.org/10.1007/s10803-006-0313-9

95. Darrou C, Pry R, Pernon E, Michelon C, Aussilloux C, Baghdadli A. Outcome of young children with autism: does the amount of intervention influence developmental trajectories? *Autism* 2010;**14**:663–77. http://dx.doi.org/10.1177/1362361310374156

96. Stella J, Mundy P, Tuchman R. Social and nonsocial factors in the Childhood Autism Rating Scale. *J Autism Dev Disord* 1999;**29**:307–17. http://dx.doi.org/10.1023/A:1022111419409

97. South M, Williams BJ, McMahon WM, Owley T, Filipek PA, Shernoff E, *et al.* Utility of the Gilliam Autism Rating Scale in research and clinical populations. *J Autism Dev Disord* 2002;**32**:593–9. http://dx.doi.org/10.1023/A:1021211232023

98. Lecavalier L. An evaluation of the Gilliam Autism Rating Scale. *J Autism Dev Disord* 2005;**35**:795–805. http://dx.doi.org/10.1007/s10803-005-0025-6

99. Pandolfi V, Magyar CI, Dill CA. Constructs assessed by the GARS-2: factor analysis of data from the standardization sample. *J Autism Dev Disord* 2010;**40**:1118–30. http://dx.doi.org/10.1007/s10803-010-0967-1

100. Gilliam J. *GARS-2: Gilliam Autism Rating Scale – Second Edition*. Austin, Texas: PRO-ED; 2006.

101. Robins DL, Fein D, Barton ML, Green JA. The modified checklist for autism in toddlers: an initial study investigating the early detection of autism and pervasive developmental disorders. *J Autism Dev Disord* 2001;**31**:131–44. http://dx.doi.org/10.1023/A:1010738829569

102. Snow AV, Lecavalier L. Sensitivity and specificity of the modified checklist for autism in toddlers and the social communication questionnaire in preschoolers suspected of having pervasive developmental disorders. *Autism* 2008;**12**:627–44. http://dx.doi.org/10.1177/1362361308097116

103. Inada N, Koyama T, Inokuchi E, Kuroda M, Kamio Y. Reliability and validity of the Japanese version of the Modified Checklist for autism in toddlers (M-CHAT). *Res Autism Spect Disord* 2011;**5**:330–6. http://dx.doi.org/10.1016/j.rasd.2010.04.016

104. Feldman MA, Ward RA, Savona D, Regehr K, Parker K, Hudson M, *et al.* Development and initial validation of a parent report measure of the Behavioral Development of Infants at Risk for Autism Spectrum Disorders. *J Autism Dev Disord* 2012;**42**:13–22. http://dx.doi.org/10.1007/s10803-011-1208-y

105. Bricker D, Squires J. *The Ages and Stages Questionnaire*. Baltimore, MD: Paul H Brookes; 1999.

106. Eaves RC. *The Pervasive Developmental Disorders Rating Scale*. Opelika, AL: Small World; 1993.

107. Williams TO, Eaves RC. The reliability of test scores for the Pervasive Developmental Disorders Rating Scale. *Psychol Sch* 2002;**39**:605–11. http://dx.doi.org/10.1002/pits.10059

108. Freeman BJ, Ritvo ER, Yokota A, Ritvo A. A scale for rating symptoms of patients with the syndrome of autism in real life settings. *J Am Acad Child Psychiatry* 1986;**25**:130–6. http://dx.doi.org/10.1016/S0002-7138(09)60610-5

109. Sevin JA, Matson JL, Coe DA, Fee VE, Sevin BM. A comparison and evaluation of three commonly used autism scales. *J Autism Dev Disord* 1991;**21**:417–32. http://dx.doi.org/10.1007/BF02206868

110. Berument SK, Rutter M, Lord C, Pickles A, Bailey A. E. Autism screening questionnaire: diagnostic validity. *Br J Psychiatry* 1999;**175**:444–51. http://dx.doi.org/10.1192/bjp.175.5.444

111. Magyar CI, Pandolfi V, Dill CA. An initial evaluation of the Social Communication Questionnaire for the assessment of autism spectrum disorders in children with Down syndrome. *J Dev Behav Pediatr* 2012;**33**:134–45. http://dx.doi.org/10.1097/DBP.0b013e318240d3d9

112. Charman T, Howlin P, Berry B, Prince E. Measuring developmental progress of children with autism spectrum disorder on school entry using parent report. *Autism* 2004;**8**:89–100. http://dx.doi.org/10.1177/1362361304040641

113. Constantino JN, Todd RD. Genetic structure of reciprocal social behavior. *Am J Psychiatry* 2000;**157**:2043–5. http://dx.doi.org/10.1176/appi.ajp.157.12.2043

114. Constantino JN, Gruber CP, Davis S, Hayes S, Passanante N, Przybeck T. The factor structure of autistic traits. *J Child Psychol Psychiatry* 2004;**45**:719–26. http://dx.doi.org/10.1111/j.1469-7610.2004.00266.x

115. Bolte S, Poustka F, Constantino JN. Assessing autistic traits: cross-cultural validation of the social responsiveness scale (SRS). *Autism Res* 2008;**1**:354–63. http://dx.doi.org/10.1002/aur.49

116. Duku E, Vaillancourt T, Szatmari P, Georgiades S, Zwaigenbaum L, Smith IM, *et al.* Investigating the measurement properties of the social responsiveness scale in preschool children with autism spectrum disorders. *J Autism Dev Disord* 2013;**43**:860–8. http://dx.doi.org/10.1007/s10803-012-1627-4

117. Pine E, Luby J, Abbacchi A, Constantino JN. Quantitative assessment of autistic symptomatology in preschoolers. *Autism* 2006;**10**:344–52. http://dx.doi.org/10.1177/1362361306064434

118. Constantino JN, Abbacchi AM, Lavesser PD, Reed H, Givens L, Chiang L, *et al.* Developmental course of autistic social impairment in males. *Dev Psychopathol* 2009;**21**:127–38. http://dx.doi.org/10.1017/S095457940900008X

119. Rimland B, Edelson M. The Autism Treatment Evaluation Checklist (ATEC) San Diego, CA: Autism Research Institute; 1999. URL: www.autism.com/ind_atec_report.asp (accessed 2 March 2015).

120. Magiati I, Moss J, Yates R, Charman T, Howlin P. Is the Autism Treatment Evaluation Checklist a useful tool for monitoring progress in children with autism spectrum disorders? *J Intellect Disabil Res* 2011;**55**:302–12. http://dx.doi.org/10.1111/j.1365-2788.2010.01359.x

121. Geier DA, Kern JK, Geier MR. A comparison of the Autism Treatment Evaluation Checklist (ATEC) and the Childhood Autism Rating Scale (CARS) for the quantitative evaluation of autism. *J Ment Health Res Intellect Disabil* 2013;**6**:255–67. http://dx.doi.org/10.1080/19315864.2012.681340

122. Cohen IL, Schmidt-Lackner S, Romanczyk R, Sudhalter V. The PDD Behavior Inventory: a rating scale for assessing response to intervention in children with pervasive developmental disorder. *J Autism Dev Disord* 2003;**33**:31–45. http://dx.doi.org/10.1023/A:1022226403878

123. Cohen IL. Criterion-related validity of the PDD Behavior Inventory. *J Autism Dev Disord* 2003;**33**:47–53. http://dx.doi.org/10.1023/A:1022278420716

124. Wetherby A, Prizant B, Hutchinson TA. Communicative, social/affective, and symbolic profiles of young children with autism and pervasive developmental disorders. *Am J Speech Lang Pathol* 1998;**7**:79–91. http://dx.doi.org/10.1044/1058-0360.0702.79

125. Wetherby A, Prizant B. *Communication and Symbolic Behavior Scales Developmental Profile-First Normed Edition*. Baltimore, MD: Paul H Brookes; 2002.

126. Wetherby AM, Woods J, Allen L, Cleary J, Dickinson H, Lord C. Early indicators of autism spectrum disorders in the second year of life. *J Autism Dev Disord* 2004;**34**:473–93. http://dx.doi.org/10.1007/s10803-004-2544-y

127. Mundy P, Hogan A, Doehring P. *A Preliminary Manual for the Abridged Early Social Communication Scales (ESCS)*. Hillsdale, NJ: Erlbaum; 1996.

128. Mundy P, Delgado C, Block J, Venezia M, Hogan A, Seibert J. *A Manual For The Abridged Early Social Communication Scales (ESCS)*. Coral Gables, FL: University of Miami, Psychology Department; 2003.

129. Luyster RJ, Kadlec MB, Carter A, Tager-Flusberg H. Language assessment and development in toddlers with autism spectrum disorders. *J Autism Dev Disord* 2008;**38**:1426–38. http://dx.doi.org/10.1007/s10803-007-0510-1

130. Rogers SJ, Stackhouse T, Hepburn SL, Wehner EA. Imitation performance in toddlers with autism and those with other developmental disorders. *J Child Psychol Psychiatry* 2003;**44**:763–81. http://dx.doi.org/10.1111/1469-7610.00162

131. Young GS, Rogers SJ, Hutman T, Rozga A, Sigman M, Ozonoff S. Imitation from 12 to 24 months in autism and typical development: a longitudinal Rasch analysis. *Dev Psychol* 2011;**47**:1565–78. http://dx.doi.org/10.1037/a0025418

132. Malvy J, Roux S, Zakian A, Debuly S, Sauvage D, Barthelemy C. A brief clinical scale for the early evaluation of imitation disorders in autism. *Autism* 1999;**3**:357–69. http://dx.doi.org/10.1177/1362361399003004004

133. Stone WL, Ousley OY, Yoder PJ, Hogan KL, Hepburn SL. Nonverbal communication in two- and three-year-old children with autism. *J Autism Dev Disord* 1997;**27**:677–96. http://dx.doi.org/10.1023/A:1025854816091

134. Ingersoll B, Meyer K. Do object and gesture imitation skills represent independent dimensions in autism? *J Dev Phys Disabil* 2011;**23**:421–31. http://dx.doi.org/10.1007/s10882-011-9237-1

135. Vanvuchelen M, Roeyers H, De Weerdt W. Development and initial validation of the Preschool Imitation and Praxis Scale (PIPS). *Res Autism Spect Disord* 2011;**5**:463–73. http://dx.doi.org/10.1016/j.rasd.2010.06.010

136. Vanvuchelen M, Vochten C. How much change is true change? The smallest detectable difference of the Preschool Imitation and Praxis Scale (PIPS) in preschoolers with intellectual disabilities of heterogeneous aetiology. *Res Dev Disabil* 2011;**32**:180–7. http://dx.doi.org/10.1016/j.ridd.2010.09.019

137. Drew A, Baird G, Taylor E, Milne E, Charman T. The Social Communication Assessment for Toddlers with Autism (SCATA): an instrument to measure the frequency, form and function of communication in toddlers with autism spectrum disorder. *J Autism Dev Disord* 2007;**37**:648–66. http://dx.doi.org/10.1007/s10803-006-0224-9

138. Cuccaro ML, Shao Y, Grubber J, Slifer M, Wolpert CM, Donnelly SL, *et al.* Factor analysis of restricted and repetitive behaviors in autism using the Autism Diagnostic Interview-R. *Child Psychiatry Hum Dev* 2003;**34**:3–17. http://dx.doi.org/10.1023/A:1025321707947

139. De Bildt A, Oosterling IJ, Lang ND, Kuijper S, Dekker V, Sytema S, *et al.* How to use the ADI-R for classifying autism spectrum disorders? Psychometric properties of criteria from the literature in 1,204 Dutch children. *J Autism Dev Disord* 2013;**43**:2280–94. http://dx.doi.org/10.1007/s10803-013-1783-1

140. Ward-King J, Cohen IL, Penning H, Holden JJ. Brief report: telephone administration of the autism diagnostic interview-revised: reliability and suitability for use in research. *J Autism Dev Disord* 2010;**40**:1285–90. http://dx.doi.org/10.1007/s10803-010-0987-x

141. Smith CJ, Lang CM, Kryzak L, Reichenberg A, Hollander E, Silverman JM. Familial associations of intense preoccupations, an empirical factor of the restricted, repetitive behaviors and interests domain of autism. *J Child Psychol Psychiatry* 2009;**50**:982–90. http://dx.doi.org/10.1111/j.1469-7610.2009.02060.x

142. Lam KS, Bodfish JW, Piven J. Evidence for three subtypes of repetitive behavior in autism that differ in familiality and association with other symptoms. *J Child Psychol Psychiatry* 2008;**49**:1193–200. http://dx.doi.org/10.1111/j.1469-7610.2008.01944.x

143. Bishop SL, Richler J, Lord C. Association Between Restricted and Repetitive Behaviors and Nonverbal IQ in Children with Autism Spectrum Disorders. *Child Neuropsychol* 2006;**12**:247–67. http://dx.doi.org/10.1080/09297040600630288

144. Richler J, Huerta M, Bishop SL, Lord C. Developmental trajectories of restricted and repetitive behaviors and interests in children with autism spectrum disorders. *Dev Psychopathol* 2010;**22**:55–69. http://dx.doi.org/10.1017/S0954579409990265

145. Shao Y, Cuccaro ML, Hauser ER, Raiford KL, Menold MM, Wolpert CM, *et al.* Fine mapping of autistic disorder to chromosome 15q11–q13 by use of phenotypic subtypes. *Am J Hum Genet* 2003;**72**:539–48. http://dx.doi.org/10.1086/367846

146. Lecavalier L, Leone S, Wiltz J. The impact of behaviour problems on caregiver stress in young people with autism spectrum disorders. *J Intellect Disabil Res* 2006;**50**:172–83. http://dx.doi.org/10.1111/j.1365-2788.2005.00732.x

147. Szatmari P, Georgiades S, Bryson S, Zwaigenbaum L, Roberts W, Mahoney W, *et al.* Investigating the structure of the restricted, repetitive behaviours and interests domain of autism. *J Child Psychol Psychiatry* 2006;**47**:582–90. http://dx.doi.org/10.1111/j.1469-7610.2005.01537.x

148. Mooney EL, Gray KM, Tonge BJ, Sweeney DJ, Taffe JR. Factor analytic study of repetitive behaviours in young children with pervasive developmental disorders. *J Autism Dev Disord* 2009;**39**:765–74. http://dx.doi.org/10.1007/s10803-008-0680-5

149. Ben Itzchak E, Lahat E, Burgin R, Zachor AD. Cognitive, behavior and intervention outcome in young children with autism. *Res Dev Disabil* 2008;**29**:447–58. http://dx.doi.org/10.1016/j.ridd.2007.08.003

150. Bodfish JW, Symons FJ, Parker DE, Lewis MH. Varieties of repetitive behavior in autism: comparisons to mental retardation. *J Autism Dev Disord* 2000;**30**:237–43. http://dx.doi.org/10.1023/A:1005596502855

151. Lam KS, Aman MG. The Repetitive Behavior Scale-Revised: independent validation in individuals with autism spectrum disorders. *J Autism Dev Disord* 2007;**37**:855–66. http://dx.doi.org/10.1007/s10803-006-0213-z

152. Mirenda P, Smith IM, Vaillancourt T, Georgiades S, Duku E, Szatmari P, *et al.* Validating the Repetitive Behavior Scale-revised in young children with autism spectrum disorder. *J Autism Dev Disord* 2010;**40**:1521–30. http://dx.doi.org/10.1007/s10803-010-1012-0

153. Silva LM, Schalock M. Autism Parenting Stress Index: initial psychometric evidence. *J Autism Dev Disord* 2012;**42**:566–74. http://dx.doi.org/10.1007/s10803-011-1274-1

154. Dunn W. *The Sensory Profile: User's Manual*. San Antonio, TX: Psychological Corporation; 1999.

155. Brown T, Leo M, Austin DW. Discriminant validity of the Sensory Profile in Australian children with autism spectrum disorder. *Phys Occupat Ther Pediatr* 2008;**28**:253–66. http://dx.doi.org/10.1080/01942630802224983

156. O'Brien J, Tsermentseli S, Cummins O, Happe F, Heaton P, Spencer J. Discriminating children with autism from children with learning difficulties with an adaptation of the Short Sensory Profile. *Early Child Dev Care* 2009;**179**:383–94. http://dx.doi.org/10.1080/03004430701567926

157. Wiggins LD, Robins DL, Bakeman R, Adamson LB. Brief report: sensory abnormalities as distinguishing symptoms of autism spectrum disorders in young children. *J Autism Dev Disord* 2009;**39**:1087–91. http://dx.doi.org/10.1007/s10803-009-0711-x

158. Carrow-Woolfolk E. *Comprehensive Assessment of Spoken Language*. Circle Pines, MN: American Guidance Service; 1999.

159. Reichow B, Salamack S, Paul R, Volkmar FR, Klin A. Pragmatic assessment in autism spectrum disorders: a comparison of a standard measure with parent report. *Commun Disord Q* 2008;**29**:169–76. http://dx.doi.org/10.1177/1525740108318697

160. Fenson L, Dale PS, Reznick JS, Thal D, Bates E, Hartung JP, *et al. The MacArthur Communicative Development Inventories: User's Guide and Technical Manual*. 1st edn. San Diego, CA: Singular Publishing Group; 1993.

161. Fenson L, Dale P, Reznick J, Thal D, Bates E, Hartung J, *et al. MacArthur Communicative Development Inventories: User's Guide and Technical Manual*. 2nd edn. Baltimore, MD: Paul H Brookes; 2003.

162. Bruckner C, Yoder P, Stone W, Saylor M. Construct validity of the MCDI-I Receptive Vocabulary scale can be improved: differential item functioning between toddlers with autism spectrum disorders and typically developing infants. *J Speech Lang Hear Res* 2007;**50**:1631–8. http://dx.doi.org/10.1044/1092-4388(2007/110)

163. Mullen EM. *Mullen Scales of Early Learning: AGS edition*. Circle Pines, MN: American Guidance Service Inc.; 1995.

164. Burns TG, King TZ, Spencer KS. Mullen scales of early learning: the utility in assessing children diagnosed with autism spectrum disorders, cerebral palsy, and epilepsy. *Appl Neuropsychol Child* 2013;**2**:33–42. http://dx.doi.org/10.1080/21622965.2012.682852

165. Zimmerman IL, Steiner VG, Pond RE. *Preschool Language Scale*. 4th edn. San Antonio, TX: The Psychological Corporation; 2002.

166. Volden J, Smith IM, Szatmari P, Bryson S, Fombonne E, Mirenda P, *et al.* Using the preschool language scale, fourth edition to characterize language in preschoolers with autism spectrum disorders. *Am J Speech Lang Pathol* 2011;**20**:200–8. http://dx.doi.org/10.1044/1058-0360(2011/10-0035)

167. Sparrow S, Balla D, Cicchetti D. *Vineland Adaptive Behavior Scales: Survey Form Manual*. Circle Pines, MN: American Guidance Service; 1984.

168. Harris SL. *The Vineland Adaptive Behavior Scales for Young Children with Autism*. Austin, TX: Pro-Ed; 1995.

169. Paul R, Miles S, Cicchetti D, Sparrow S, Klin A, Volkmar F, *et al.* Adaptive behavior in autism and Pervasive Developmental Disorder-Not Otherwise Specified: microanalysis of scores on the Vineland Adaptive Behavior Scales. *J Autism Dev Disord* 2004;**34**:223–8. http://dx.doi.org/10.1023/B:JADD.0000022612.18116.46

170. Wells K, Condillac R, Perry A, Factor DC. A comparison of three adaptive behaviour measures in relation to cognitive level and severity of autism. *J Dev Disabil* 2009;**15**:55–63.

171. Sparrow SS, Carter AS, Cicchetti DV. *Vineland Screener: Overview, Reliability, Validity, Administration and Scoring*. New Haven, CT: Yale University Child Study Centre; 1993.

172. Roid GH, Miller LJ, editors. *Leiter International Performance Scale – Revised: Examiner's Manual*. Wood Dale, IL: Stoelting; 1997.

173. Scattone D, Raggio DJ, May W. Brief report: concurrent validity of the Leiter-R and KBIT-2 scales of nonverbal intelligence for children with autism and language impairments. *J Autism Dev Disord* 2012;**42**:2486–90. http://dx.doi.org/10.1007/s10803-012-1495-y

174. Tsatsanis KD, Dartnall N, Cicchetti D, Sparrow SS, Klin A, Volkmar FR. Concurrent validity and classification accuracy of the Leiter and Leiter-R in low-functioning children with autism. *J Autism Dev Disord* 2003;**33**:23–30. http://dx.doi.org/10.1023/A:1022274219808

175. Grondhuis SN, Mulick JA. Comparison of the Leiter International Performance Scale-Revised and the Stanford-Binet Intelligence Scales, 5th edition, in children with autism spectrum disorders. *Am J Intellect Dev Disabil* 2013;**118**:44–54. http://dx.doi.org/10.1352/1944-7558-118.1.44

176. Bishop SL, Guthrie W, Coffing M, Lord C. Convergent validity of the Mullen Scales of Early Learning and the Differential Ability Scales in children with autism spectrum disorders. *Am J Intellect Dev Disabil* 2011;**116**:331–43. http://dx.doi.org/10.1352/1944-7558-116.5.331

177. Roid GH. *Stanford-Binet Intelligence Scales, Fifth Edition (SB:V)*. Itasca, IL: Riverside Publishing; 2003.

178. Wechsler D. *The Wechsler Preschool and Primary Scale of Intelligence–Revised*. San Antonio, TX: The Psychological Corporation; 1989.

179. Wechsler D. *Wechsler Preschool and Primary Scale of Intelligence – Third Edition (WPPSI – III)*. San Antonio, TX: The Psychological Corporation; 2002.

180. Yang P, Jong Y, Hsu H, Lung F. Role of assessment tests in the stability of intelligence scoring of pre-school children with uneven/delayed cognitive profile. *J Intellect Disabil Res* 2011;**55**:453–61. http://dx.doi.org/10.1111/j.1365-2788.2011.01396.x

181. Reynolds CR, Kamphaus RW. *Behavior Assessment System for Children*. 2nd edn. Circle, Pines, MN: American Guidance Service; 2004.

182. Hass MR, Brown RS, Brady J, Johnson DB. Validating the BASC-TRS for use with children and adolescents with an educational diagnosis of autism. *Remed Spec Educ* 2010;**33**:173–83. http://dx.doi.org/10.1177/0741932510383160

183. Mahan S, Matson JL. Children and adolescents with autism spectrum disorders compared to typically developing controls on the Behavioral Assessment System for Children, Second Edition (BASC-2). *Res Autism Spect Disord* 2011;**5**:119–25. http://dx.doi.org/10.1016/j.rasd.2010.02.007

184. Achenbach TM, Rescorla LA. *Manual for the ASEBA Preschool Forms and Profiles*. Burlington, VT: University of Vermont, Research Center for Children, Youth and Families; 2000.

185. Pandolfi V, Magyar CI, Dill CA. Confirmatory factor analysis of the Child Behavior Checklist 1.5–5 in a sample of children with autism spectrum disorders. *J Autism Dev Disord* 2009;**39**:986–95. http://dx.doi.org/10.1007/s10803-009-0716-5

186. Pandolfi V, Magyar CI, Dill CA. An initial psychometric evaluation of the CBCL 6–18 in a sample of youth with autism spectrum disorders. *Res Autism Spect Disord* 2012;**6**:96–108. http://dx.doi.org/10.1016/j.rasd.2011.03.009

187. Matson JL, Boisjoli JA, Hess JA, Wilkins J. Comorbid psychopathology factor structure on the Baby and Infant Screen for Children with aUtIsm Traits-Part 2 (BISCUIT-Part 2). *Res Autism Spect Disord* 2011;**5**:426–32. http://dx.doi.org/10.1016/j.rasd.2010.06.005

188. Matson JL, Fodstad JC, Mahan S, Sevin JA. Cutoffs, Norms, and Patterns of Comorbid Difficulties in Children with an ASD on the Baby and Infant Screen for Children with aUtIsm Traits (BISCUIT-Part 2). *Res Autism Spect Disord* 2009;**3**:977–88. http://dx.doi.org/10.1016/j.rasd.2009.06.001

189. Briggs-Gowan MJ, Carter AS, Irwin JR, Wachtel K, Cicchetti DV. The Brief Infant-Toddler Social and Emotional Assessment: screening for social-emotional problems and delays in competence. *J Pediatr Psychol* 2004;**29**:143–55. http://dx.doi.org/10.1093/jpepsy/jsh017

190. Karabekiroglu K, Briggs-Gowan MJ, Carter AS, Rodopman-Arman A, Akbas S. The clinical validity and reliability of the Brief Infant-Toddler Social and Emotional Assessment (BITSEA). *Infant Behav Dev* 2010;**33**:503–9. http://dx.doi.org/10.1016/j.infbeh.2010.07.001

191. Achenbach TM, Rescorla LA. *Manual for ASEBA School-Age Forms and Profiles*. Burlington, VT: University of Vermont, Research Center for Children, Youth and Families; 2001.

192. Schaffer D, Gould MS, Brasic J, Ambrosini P, Bird H, Aluwahlia S, *et al.* A Children's Global Assessment Scale (CGAS). *Arch Gen Psychiatry* 1983;**40**:1228–31. http://dx.doi.org/10.1001/archpsyc.1983.01790100074010

193. Lundh A, Forsman M, Serlachius E, Lichtenstein P, Landen M. Outcomes of child psychiatric treatment. *Acta Psychiatr Scand* 2013;**128**:34–44. http://dx.doi.org/10.1111/acps.12043

194. Briggs-Gowan M, Carter AS. Preliminary acceptability and psychometrics of the Infant–Toddler Social and Emotional Assessment (ITSEA): a new adult-report questionnaire. *Infant Mental Health* 1998;**19**:422–45. http://dx.doi.org/10.1002/(SICI)1097-0355(199824)19:4<422::AID-IMHJ5>3.0.CO;2-U

195. Visser JC, Smeekens S, Rommelse N, Verkes RJ, Van der Gaag RJ, Buitelaar JK. Assessment of psychopathology in 2- to 5-year-olds: applying the infant-toddler social emotional assessment. *Infant Ment Health J* 2010;**31**:611–29. http://dx.doi.org/10.1002/imhj.20273

196. Robertson J, Tanguay P, L'Ecuyer S, Sims A, Waltrip C. Domains of social communication handicap in autism spectrum disorder. *J Am Acad Child Adolesc Psychiatry* 1999;**38**:738–45. http://dx.doi.org/10.1097/00004583-199906000-00022

197. Tanguay PE, Robertson J, Derrick A. A dimensional classification of autism spectrum disorder by social communication domains. *J Am Acad Child Adolesc Psychiatry* 1998;**37**:271–7. http://dx.doi.org/10.1097/00004583-199803000-00011

198. Aman MG, Tasse MJ, Rojahn J, Hammer D. The Nisonger CBRF: A Child Behavior Rating Form for children with developmental disabilities. *Res Dev Disabil* 1996;**17**:41–57. http://dx.doi.org/10.1016/0891-4222(95)00039-9

199. Lecavalier L, Aman MG, Hammer D, Stoica W, Mathews GL. Factor analysis of the Nisonger Child Behavior Rating Form in children with autism spectrum disorders. *J Autism Dev Disord* 2004;**34**:709–21. http://dx.doi.org/10.1007/s10803-004-5291-1

200. Tyminski RF, Moore PJ. The impact of group psychotherapy on social development in children with pervasive development disorders. *Int J Group Psychother* 2008;**58**:363–79. http://dx.doi.org/10.1521/ijgp.2008.58.3.363

201. Harris SL, Handleman JS, Belchich J, Glasberg B. The Vineland Adaptive Behavior Scales for young children with autism. *Special Services in the Schools* 1995;**10**:45–54. http://dx.doi.org/10.1300/J008v10n01_03

202. Lewis V, Boucher J. *Manual of the Test of Pretend Play*. London: Harcourt Brace; 1997.

203. Clift S, Stagnitti K, DeMello L. A validational study of the test of pretend play using correlational and classificational analyses. *Child Lang Teach Ther* 1998;**14**:199–209. http://dx.doi.org/10.1191/026565998675895190

204. Aman MG, Singh NN. *Manual for the Aberrant Behavior Checklist*. East Aurora, NY: Slosson Educational Publications; 1986.

205. Karabekiroglu K, Aman MG. Validity of the aberrant behavior checklist in a clinical sample of toddlers. *Child Psychiatry Hum Dev* 2009;**40**:99–110. http://dx.doi.org/10.1007/s10578-008-0108-7

206. Sigafoos J, Pittendreigh N, Pennell D. Parent and teacher ratings of challenging behaviour in young children with developmental disabilities. *Br J Learn Disabil* 1997;**25**:13–17. http://dx.doi.org/10.1111/j.1468-3156.1997.tb00003.x

207. Brinkley J, Nations L, Abramson RK, Hall A, Wright HH, Gabriels R, *et al.* Factor analysis of the aberrant behavior checklist in individuals with autism spectrum disorders. *J Autism Dev Disord* 2007;**37**:1949–59. http://dx.doi.org/10.1007/s10803-006-0327-3

208. Matson JL, Boisjoli J, Rojahn J, Hess J. A factor analysis of challenging behaviors assessed with the baby and infant screen for children with autism traits (Biscuit-Part 3). *Res Autism Spect Disord* 2009;**3**:714–22. http://dx.doi.org/10.1016/j.rasd.2009.01.008

209. Chowdhury M, Aman MG, Scahill L, Swiezy N, Arnold LE, Lecavalier L, *et al.* The Home Situations Questionnaire-PDD version: factor structure and psychometric properties. *J Intellect Disabil Res* 2010;**54**:281–91. http://dx.doi.org/10.1111/j.1365-2788.2010.01259.x

210. Arnold LE, Aman MG, Li X, Butter EJ, Humphries K, Scahill L, *et al.* RUPP Autism Network randomized clinical trial of parent training and medication: one year follow-up. *J Am Acad Child Adolesc Psychiatry* 2012;**51**:1173–84. http://dx.doi.org/10.1016/j.jaac.2012.08.028

211. Silva LM, Schalock M. Sense and Self-Regulation Checklist, a measure of comorbid autism symptoms: Initial psychometric evidence. *Am J Occupat Ther* 2012;**66**:177–86. http://dx.doi.org/10.5014/ajot.2012.001578

212. Bricker D. *AEPS Measurement for Birth to Three Years, Volume 1*. Baltimore, MD: Paul H Brookes Publishing; 1993.

213. Wang H-T, Sandall SR, Davis CA, Thomas CJ. Social skills assessment in young children with autism: a comparison evaluation of the SSRS and PKBS. *J Autism Dev Disord* 2011;**41**:1487–95. http://dx.doi.org/10.1007/s10803-010-1175-8

214. Schopler E, Reichler RJ, Bashford A, Lansing M, Marcus L. *Individualized assessment and treatment for autistic and developmentally disabled children. Psychoeducational profile-revised (PEP-R)*. Austin, TX: Pro-Ed; 1990.

215. Alwinesh MT, Joseph RB, Daniel A, Abel JS, Shankar SR, Mammen P, *et al.* Psychometrics and utility of Psycho-Educational Profile-Revised as a developmental quotient measure among children with the dual disability of intellectual disability and autism. *J Intellect Disabil* 2012;**16**:193–203. http://dx.doi.org/10.1177/1744629512455594

216. Shek DT, Tsang SK, Lam LL, Tang FL, Cheung PM. Psychometric properties of the Chinese version of the Psycho-educational Profile-Revised (CPEP-R). *J Autism Dev Disord* 2005;**35**:37–44. http://dx.doi.org/10.1007/s10803-004-1029-3

217. Steerneman P, Muris P, Merckelbach H, Willems H. Brief report: assessment of development and abnormal behavior in children with pervasive developmental disorders: evidence for the reliability and validity of the Revised Psychoeducational Profile. *J Autism Dev Disord* 1997;**27**:177–85. http://dx.doi.org/10.1023/A:1025843908339

218. Villa S, Micheli E, Villa L, Pastore V, Crippa A, Molteni M. Further empirical data on the psychoeducational profile-revised (PEP-R): reliability and validation with the Vineland adaptive behavior scales. *J Autism Dev Disord* 2010;**40**:334–41. http://dx.doi.org/10.1007/s10803-009-0877-2

219. Heimann M, Laberg KE, Nordoen B. Imitative interaction increases social interest and elicited imitation in non-verbal children with autism. *Infant Child Dev* 2006;**15**:297–309. http://dx.doi.org/10.1002/icd.463

220. Schopler E, Lansing MD, Reichler RJ, Marcus LM. *Examiner's Manual of Psychoeducational Profile*. 3rd edn. Austin, TX: Pro-Ed Incorporation; 2005.

221. Fu C-P, Hsieh C-L, Tseng M-H, Chen Y-L, Huang W-T, Wu P-C, *et al.* Inter-rater reliability and smallest real difference of the Chinese psychoeducational profile-third edition for children with autism spectrum disorder. *Res Autism Spect Disord* 2010;**4**:89–94. http://dx.doi.org/10.1016/j.rasd.2009.09.002

222. Chen K-L, Chiang F-M, Tseng M-H, Fu C-P, Hsieh C-L. Responsiveness of the Psychoeducational Profile-third edition for children with autism spectrum disorders. *J Autism Dev Disord* 2011;**41**:1658–64. http://dx.doi.org/10.1007/s10803-011-1201-5

223. Fu C-P, Chen K-L, Tseng M-H, Chiang F-M, Hsieh C-L. Reliability and validity of the Psychoeducational Profile-Third Edition caregiver report in children with autism spectrum disorders. *Res Autism Spect Disord* 2012;**6**:115–22. http://dx.doi.org/10.1016/j.rasd.2011.03.011

224. Bruininks R, Woodcock R, Weatherman R, Hill B. *Scales of Independent Behaviour – Revised*. Park Allen, TX: DLM Teaching Resources; 1996.

225. Brown L, Bundy MB, Gore JS. Patterns of adaptive performance by individuals with autism spectrum disorders on the Scales of Independent Behavior-Revised (SIB-R). *Int J Disabil Hum Dev* 2010;**9**:315–18. http://dx.doi.org/10.1515/IJDHD.2010.035

226. Silva LMT, Schalock M, Ayres R, Bunse C, Budden S. Qigong massage treatment for sensory and self-regulation problems in young children with autism: a randomized controlled trial. *Am J Occupat Ther* 2009;**63**:423–32. http://dx.doi.org/10.5014/ajot.63.4.423

227. Silva L, Schalock M. Sense and Self-Regulation Checklist: initial psychometric evidence and findings. *Am J Occupat Ther* 2012;**66**:177–86. http://dx.doi.org/10.5014/ajot.2012.001578

228. Abidin RR. *Parenting Stress Index: Professional Manual*. 3rd edn. Odessa, FL: Psychological Assessment Resources; 1995.

229. Zaidman-Zait A, Mirenda P, Zumbo BD, Wellington S, Dua V, Kalynchuk K. An item response theory analysis of the Parenting Stress Index-Short Form with parents of children with autism spectrum disorders. *J Child Psychol Psychiatry* 2010;**51**:1269–77. http://dx.doi.org/10.1111/j.1469-7610.2010.02266.x

230. Zaidman-Zait A, Mirenda P, Zumbo BD, Georgiades S, Szatmari P, Bryson S, *et al.* Factor analysis of the Parenting Stress Index-Short Form form with parents of young children with autism spectrum disorders. *Autism Res* 2011;**4**:336–46. http://dx.doi.org/10.1002/aur.213

231. WN, Greenberg MT, Crnic K. A short form of the questionnaire on resources and stress. *Am J Ment Defic* 1983;**88**:41–8.

232. Honey E, Hastings RP, McConachie H. Use of the Questionnaire on Resources and Stress (QRS-F) with parents of young children with autism. *Autism* 2005;**9**:246–55. http://dx.doi.org/10.1177/1362361305053256

233. Hudry K, Leadbitter K, Temple K, Slonims V, McConachie H, Aldred C, *et al.* Preschoolers with autism show greater impairment in receptive compared with expressive language abilities. *Int J Lang Commun Disord* 2010;**45**:681–90. http://dx.doi.org/10.3109/13682820903461493

234. Arnold LE, Aman MG, Martin A, Collier-Crespin A, Vitiello B, Tierney E, *et al.* Assessment in multi-site randomized clinical trials of patients with autistic disorder: the Autism RUPP Network. *J Autism Dev Disord* 2000;**30**:99–11. http://dx.doi.org/10.1023/A:1005451304303

235. Wolery M, Garfinkle AN. Measures in intervention research with young children who have autism. *J Autism Dev Disord* 2002;**32**:463–78. http://dx.doi.org/10.1023/A:1020598023809

236. Cunningham AB. Measuring change in social interaction skills of young children with autism. *J Autism Dev Disord* 2012;**42**:593–605. http://dx.doi.org/10.1007/s10803-011-1280-3

237. Ozonoff S, Goodlin-Jones L, Solomon M. Evidence-based assessment of autism spectrum disorders in children and adolescents. *J Clin Child Adolesc Psychol* 2005;**34**:523–40. http://dx.doi.org/10.1207/s15374424jccp3403_8

238. Anagnostou E, Jones N, Huerta M, Halladay AK, Wang P, Scahill L, *et al.* Measuring social communication behaviors as a treatment endpoint in individuals with autism spectrum disorder [published online ahead of print August 5 2014]. *Autism* 2014. http://dx.doi.org/10.1177/1362361314542955

239. Lecavalier L, Wood JJ, Halladay AK, Jones NE, Aman MG, Cook EH, *et al.* Measuring anxiety as a treatment endpoint in youth with autism spectrum disorder. *J Autism Dev Disord* 2013;**44**:1128–43. http://dx.doi.org/10.1007/s10803-013-1974-9

240. Scahill L, Aman MG, Lecavalier L, Halladay AK, Bishop SL, Bodfish JW, *et al.* Measuring repetitive behaviors as a treatment endpoint in youth with autism spectrum disorder. *Autism* 2015:**9**:38–52. http://dx.doi.org/10.1177/1362361313510069

241. Krug DA, Arick JR, Almond PJ. *Autism Screening Instrument for Educational Planning: Background and Development*. Austin, TX: University of Texas Press; 1978.

242. Lord C, Rutter M, DiLavore PC, Risi S, Gotham K, Bishop SL. *Autism Diagnostic Observation Schedule, Second Edition (ADOS-2) Manual (Part 1): Modules 1–4*. Torrance, CA: Western Psychological Services; 2012.

243. Lord C, Luyster RJ, Gotham K, Guthrie W. *Autism Diagnostic Observation Schedule, Second Edition (ADOS-2) Manual (Part II) Toddler Module*. Torrance, CA: Western Psychological Services; 2012.

244. Schopler E, Reichler J. Toward objective classification of childhood autism: Childhood Autism Rating Scale (C.A.R.S.). *J Autism Dev Disord* 1980;**10**:91–103. http://dx.doi.org/10.1007/BF02408436

245. Schopler E, Van Bourgondien ME, Wellman GJ, Love SR. *Childhood Autism Rating Scale.* 2nd edn. Los Angeles, CA: Western Psychological Services; 2010.

246. Gilliam JE. *Gilliam Autism Rating Scale*. Austin, TX: Pro-Ed; 1995.

247. Gilliam J. *GARS-3: Gilliam Autism Rating Scale – Third Edition*. Austin, TX: PRO-ED; 2013.

248. Robins DL, Fein D, Barton ML. *Modified Checklist for Autism in Toddlers (M-CHAT)*. Storrs, CT: self-published; 1999.

249. Robins DL, Casagrande K, Barton ML, Chen CA, Dumont-Mathieu T, Fein D. Validation of the modified checklist for autism in toddlers, revised with follow-up (M-CHAT-R/F). *Pediatrics* 2014;**133**:37–45. http://dx.doi.org/10.1542/peds.2013-1813

250. Eaves RC, Hooper J. A factor analysis of psychotic behavior. *J Spec Educ* 1987;**21**:130–6.

251. Rutter M, Bailey A, Lord C. *Social Communication Questionnaire*. Los Angeles, CA: Western Psychological Services; 2003.

252. Constantino JN, Gruber CP. *Social Responsiveness Scale*. Los Angeles, CA: Western Psychological Services; 2005.

253. Green J, Charman T, McConachie H, Aldred C, Slonims V, Howlin P, *et al.* Parent-mediated communication-focused treatment in children with autism (PACT): a randomised controlled trial. *Lancet* 2010;**375**:2152–60. http://dx.doi.org/10.1016/S0140-6736(10)60587-9

254. Stone WL, Coonrod EE, Pozdol SL, Turner LT. The Parent Interview for Autism-Clinical Version (PIA-CV): A measure of behavioral change for young children with autism. *Autism* 2003;**7**:9–30. http://dx.doi.org/10.1177/1362361303007001017

255. Kanne SM, Mazurek MO, Sikora D, Bellando J, Branum-Martin L, Handen B, *et al.* The Autism Impact Measure (AIM): initial development of a new tool for treatment outcome measurement. *J Autism Dev Disord* 2014;**44**:168–79. http://dx.doi.org/10.1007/s10803-013-1862-3

256. Vanvuchelen M. *Imitation Problems in Children with Autism Spectrum Disorders. A Study of their Nature, Clinical Significance and Utility in Diagnosis*. PhD thesis. Leuven, Belgium: Katholieke Universiteit; 2009.

257. Vanvuchelen M, Roeyers H, De Weerdt W. Imitation assessment and its utility to the diagnosis of autism: evidence from consecutive clinical preschool referrals for suspected autism. *J Autism Dev Disord* 2011;**41**:484–96. http://dx.doi.org/10.1007/s10803-010-1074-z

258. Bodfish JW, Symons FW, Lewis MH. *The Repetitive Behavior Scale*. Western Carolina Center Research Reports; 1999.

259. McIntosh DN, Miller LJ, Shyu V. *Development and Validation of the Short Sensory Profile*. San Antonio, TX: Psychological Corporation; 1999.

260. Zimmerman IL, Steiner VG, Pond E. *Preschool Language Scales – Fifth Edition (PLS-5)*. San Antonio, TX: Pearson; 2011.

261. Nordahl-Hansen A, Kaale A, Ulvund SE. Inter-rater reliability of parent and preschool teacher ratings of language in children with autism. *Res Autism Spect Disord* 2013;**7**:1391–6. http://dx.doi.org/10.1016/j.rasd.2013.08.006

262. Roid GH, Miller LJ, Pomplun M, Koch C. *Leiter-3 International Performance Scale, Third Edition*. Wood Dale, IL: Stoelting Co; 2013.

263. Briggs-Gowan MJ, Carter AS. *Brief Infant-Toddler Social and Emotional Assessment (BITSEA) manual, version 2*. New Haven, CT: Yale University; 2002.

264. Shaffer D, Gould MS, Brassic J, Ambrosini P, Fisher P, Bird H, *et al.* A Children's Global Assessment Scale (CGAS). *Arch Gen Psychiatry* 1983;**40**:1228–31. http://dx.doi.org/10.1001/archpsyc.1983.01790100074010

265. Carter AS, Briggs-Gowan MJ, Jones SM, Little TD. The infant-toddler social and emotional assessment ITSEA: factor structure, reliability and validity. *J Abnorm Child Psychol* 2003;**31**:495–514. http://dx.doi.org/10.1023/A:1025449031360

266. Aman MG, Singh NN, Stewart AW, Field CJ. The Aberrant Behavior Checklist: a behavior rating scale for the assessment of treatment effects. *Am J Ment Defic* 1985;**89**:485–91.

267. Carter AS, Volkmar FR, Sparrow SS, Wang JJ, Lord C, Dawson G, *et al.* The Vineland Adaptive Behavior Scales: supplementary norms for individuals with autism. *J Autism Dev Disord* 1998;**28**:287–302. http://dx.doi.org/10.1023/A:1026056518470

268. Abidin RR. *Parenting Stress Index 4th Edition Short Form (PSI-4-SF)*. Odessa, FL: Psychological Assessment Resources; 2012.

269. Sclare I. *Child Psychology Portfolio*. Windsor: NFER-Nelson; 1997.

270. Seibert JM, Hogan AE, Mundy PC. Assessing interactional competencies: The Early Social-Communication Scales. *Infant Ment Health* 1982;**3**:244–5. http://dx.doi.org/10.1002/1097-0355(198224)3:4<244::AID-IMHJ2280030406>3.0.CO;2-R

271. Escalona A, Field T, Singer-Strunck R, Cullen C, Hartshorn K. Improvements in the behavior of children with autism following massage therapy. Brief report. *J Autism Dev Disord* 2001;**31**:513–16. http://dx.doi.org/10.1023/A:1012273110194

272. Owens J, Nobile C, McGuinn M, Spirito A. The children's sleep habits questionnaire: construction and validation of a sleep survey for school-aged children. *Sleep* 2000;**23**:1043–51.

273. Malow BA, Crowe C, Henderson L, McGrew SG, Wang L, Song Y, *et al.* A sleep habits questionnaire for children with autism spectrum disorders. *J Child Neurol* 2009;**24**:19–24. http://dx.doi.org/10.1177/0883073808321044

274. Lukens CT, Linscheid TR. Development and validation of an inventory to assess mealtime behavior problems in children with autism. *J Autism Dev Disord* 2008;**38**:342–52. http://dx.doi.org/10.1007/s10803-007-0401-5

275. Ladd GW, Price JM. Predicting children's social and school adjustment following the transition from preschool to kindergarten. *Child Dev* 1987;**58**:1168–89. http://dx.doi.org/10.2307/1130613

276. Ladd GW, Buhs ES, Seid M. Children's initial sentiments about kindergarten: is school liking an antecedent of early classroom participation and achievement? *Merrill-Palmer Q* 2000;**46**:255–79.

277. Arnold LE, Vitiello B, McDougle CJ, Scahill L, Shah B, Gonzalez NM, *et al.* Parent-defined target symptoms respond to risperidone in RUPP autism study: customer approach to clinical trials. *J Am Acad Child Adolesc Psychiatry* 2003;**42**:1443–50. http://dx.doi.org/10.1097/00004583-200312000-00011

278. Bearss K, Johnson C, Handen B, Smith T, Scahill L. A pilot study of parent training in young children with autism spectrum disorder and disruptive behavior. *J Autism Dev Disord* 2013;**43**:829–40. http://dx.doi.org/10.1007/s10803-012-1624-7

279. Ruble L, McGrew JH, Toland MD. Goal attainment scaling as an outcome measure in randomized controlled trials of psychosocial interventions in autism. *J Autism Dev Disord* 2012;**42**:1974–83. http://dx.doi.org/10.1007/s10803-012-1446-7

280. Payakachat N, Tilford JM, Koyacs E, Kuhlthau K. Autism spectrum disorders: a review of measures for clinical, health services and cost-effectiveness applications. *Exp Rev Pharmacoecon Outcome Res* 2012;**12**:485–503. http://dx.doi.org/10.1586/erp.12.29

281. Khanna R, Jariwala K, Bentley JP. Psychometric properties of the EuroQol Five Dimensional Questionnaire (EQ-5D-3L) in caregivers of autistic children. *Qual Life Res* 2013;**22**:2909–20. http://dx.doi.org/10.1007/s11136-013-0423-8

282. Wild D, Grove A, Martin M, Eremenco S, McElroy S, Verjee-Lorenz A, *et al.* Principles of good practice for the translation and cultural adaptation process for patient-reported outcomes (PRO) measures: report of the ISPOR Task Force for Translation and Cultural Adaptation. *Value Health* 2005;**8**:94–104. http://dx.doi.org/10.1111/j.1524-4733.2005.04054.x

283. Charman T. Why is joint attention a pivotal skill in autism? *Philos Trans R Soc Lond B Biol Sci* 2003;**358**:315–24. http://dx.doi.org/10.1098/rstb.2002.1199

284. Toth K, Munson J, Meltzoff AN, Dawson G. Early predictors of communication development in young children with autism spectrum disorder: joint attention, imitation, and toy play. *J Autism Dev Disord* 2006;**36**:993–1005. http://dx.doi.org/10.1007/s10803-006-0137-7

285. White PJ, O'Reilly M, Streusand W, Levine A, Sigafoos J, Lancioni G, *et al.* Best practices for teaching joint attention: a systematic review of the intervention literature. *Res Autism Spect Disord* 2011;**5**:1283–95. http://dx.doi.org/10.1016/j.rasd.2011.02.003

286. Ingersoll B. Effect of a focused imitation intervention on social functioning in children with autism. *J Autism Dev Disord* 2012;**42**:1768–73. http://dx.doi.org/10.1007/s10803-011-1423-6

287. Kasari C, Gulsrud AC, Wong CS, Kwon S, Locke J. Randomized controlled caregiver mediated joint engagement intervention for toddlers with autism. *J Autism Dev Disord* 2010;**40**:1045–56. http://dx.doi.org/10.1007/s10803-010-0955-5

288. Kaale A, Smith L, Sponheim E. A randomized controlled trial of preschool-based joint attention intervention for children with autism. *J Child Psychol Psychiatry* 2012;**53**:97–105. http://dx.doi.org/10.1111/j.1469-7610.2011.02450.x

289. Bitterman A, Daley TC, Misra S, Carlson E, Markowitz J. A national sample of preschoolers with autism spectrum disorders: special education services and parent satisfaction. *J Autism Dev Disord* 2008;**38**:1509–17. http://dx.doi.org/10.1007/s10803-007-0531-9

290. Callahan K, Henson RK, Cowan AK. Social validation of evidence-based practices in autism by parents, teachers, and administrators. *J Autism Dev Disord* 2008;**38**:678–92. http://dx.doi.org/10.1007/s10803-007-0434-9

291. Pituch KA, Green VA, Didden R, Lang R, O'Reilly MF, Lancioni GE, *et al.* Parent reported treatment priorities for children with autism spectrum disorders. *Res Autism Spect Disord* 2011;**5**:135–43. http://dx.doi.org/10.1016/j.rasd.2010.03.003

292. Dymond SK, Gilson CL, Myran SP. Services for children with autism spectrum disorders. *J Disabil Policy Stud* 2007;**18**:133–47. http://dx.doi.org/10.1177/10442073070180030201

293. Hackett L, Shaikh S, Theodosiou L. Parental perceptions of the assessment of autistic spectrum disorders in a tier three service. *Child Adolesc Ment Health* 2009;**14**:127–32. http://dx.doi.org/10.1111/j.1475-3588.2008.00508.x

294. Read N, Schofield A. Autism: are mental health services failing children and parents? *J Fam Health Care* 2010;**20**:120–4.

295. Moore K, McConkey R, Sines D, Cassidy A. Improving diagnostic and assessment services for children with autistic spectrum disorders. *Early Child Dev Care* 1999;**154**:1–11. http://dx.doi.org/10.1080/0030443991540101

296. Bennett T, Szatmari P, Bryson S, Volden J, Zwaigenbaum L, Vaccarella L, *et al.* differentiating autism and Asperger syndrome on the basis of language delay or impairment. *J Autism Dev Disord* 2008;**38**:616–25. http://dx.doi.org/10.1007/s10803-007-0428-7

297. Gupta A, Singhal N. Language and learning skills and symptoms in children with autistic spectrum disorders. *Asia Pac Disabil Rehabil J* 2009;**20**:59–83.

298. Jocelyn LJ, Casiro OG, Beattie D, Bow J, Kneisz J. Treatment of children with autism: a randomized controlled trial to evaluate a caregiver-based intervention program in community day-care centers. *J Dev Behav Pediatr* 1998;**19**:326–34. http://dx.doi.org/10.1097/00004703-199810000-00002

299. Silva LMT, Cignolini A, Warren R, Budden S, Skowron-Gooch A. Improvement in sensory impairment and social interaction in young children with autism following treatment with an original Qigong massage methodology. *Am J Chin Med* 2007;**35**:393–406. http://dx.doi.org/10.1142/S0192415X07004916

300. Silva LMT, Ayres R, Schalock M. Outcomes of a pilot training program in a qigong massage intervention for young children with autism. *Am J Occup Ther* 2008;**62**:538–46. http://dx.doi.org/10.5014/ajot.62.5.538

301. Silva LM, Schalock M, Gabrielsen K. Early intervention for autism with a parent-delivered ongoing massage program: a randomized controlled trial. *Am J Occup Ther* 2011;**65**:550–9. http://dx.doi.org/10.5014/ajot.2011.000661

302. Szatmari P, Bryson SE, Streiner DL, Wilson F, Archer L, Ryerse C. Two-year outcome of preschool children with autism or Asperger's syndrome. *Am J Psychiatry* 2000;**157**:1980–7. http://dx.doi.org/10.1176/appi.ajp.157.12.1980

303. Zhang R, Jia MX, Zhang JS, Xu XJ, Shou XJ, Zhang XT, *et al.* Transcutaneous electrical acupoint stimulation in children with autism and its impact on plasma levels of arginine-vasopressin and oxytocin: a prospective single-blinded controlled study. *Res Dev Disabil* 2012;**33**:1136–46. http://dx.doi.org/10.1016/j.ridd.2012.02.001

304. Bennett T, Boyle M, Georgiades K, Georgiades S, Thompson A, Duku E, *et al.* Influence of reporting effects on the association between maternal depression and child autism spectrum disorder behaviors. *J Child Psychol Psychiatry* 2012;**53**:89–96. http://dx.doi.org/10.1111/j.1469-7610.2011.02451.x

305. Brian J, Bryson SE, Garon N, Roberts W, Smith IM, Szatmari P, *et al.* Clinical assessment of autism in high-risk 18-month-olds. *Autism* 2008;**12**:433–56. http://dx.doi.org/10.1177/1362361308094500

306. Hambly C, Fombonne E. The impact of bilingual environments on language development in children with autism spectrum disorders. *J Autism Dev Disord* 2012;**42**:1342–52. http://dx.doi.org/10.1007/s10803-011-1365-z

307. Honey E, McConachie H, Randle V, Shearer H, Couteur ASL. One-year change in repetitive behaviours in young children with communication disorders including autism. *J Autism Dev Disord* 2008;**38**:1439–50. http://dx.doi.org/10.1007/s10803-006-0191-1

308. Magiati I, Charman T, Howlin P. A two-year prospective follow-up study of community-based early intensive behavioural intervention and specialist nursery provision for children with autism spectrum disorders. *J Child Psychol Psychiatry* 2007;**48**:803–12. http://dx.doi.org/10.1111/j.1469-7610.2007.01756.x

309. Magiati I, Moss J, Charman T, Howlin P. Patterns of change in children with autism spectrum disorders who received community based comprehensive interventions in their pre-school years: a seven year follow-up study. *Res Autism Spect Disord* 2011;**5**:1016–27. http://dx.doi.org/10.1016/j.rasd.2010.11.007

310. Mayo J, Chlebowski C, Fein DA, Eigsti I-M. Age of first words predicts cognitive ability and adaptive skills in children with ASD. *J Autism Dev Disord* 2013;**43**:253–64. http://dx.doi.org/10.1007/s10803-012-1558-0

311. Mooney EL, Gray KM, Tonge BJ. Early features of autism: repetitive behaviours in young children. *Eur Child Adolesc Psychiatry* 2006;**15**:12–18. http://dx.doi.org/10.1007/s00787-006-0499-6

312. Munson J, Dawson G, Sterling L, Beauchaine T, Zhou A, Koehler E, *et al.* Evidence for latent classes of IQ in young children with autism spectrum disorder. *Am J Ment Retard* 2008;**113**:439–52. http://dx.doi.org/10.1352/2008.113:439-452

313. Ozonoff S, Iosif A-M, Baguio F, Cook IC, Hill MM, Hutman T, *et al.* A prospective study of the emergence of early behavioral signs of autism. *J Am Acad Child Adolesc Psychiatry* 2010;**49**:256–66, e1–2.

314. Pry R, Petersen A, Baghdadli A. The relationship between expressive language level and psychological development in children with autism 5 years of age. *Autism* 2005;**9**:179–89. http://dx.doi.org/10.1177/1362361305047222

315. Richler J, Bishop SL, Kleinke JR, Lord C. Restricted and repetitive behaviors in young children with autism spectrum disorders. *J Autism Dev Disord* 2007;**37**:73–85. http://dx.doi.org/10.1007/s10803-006-0332-6

316. Werner E, Dawson G, Munson J, Osterling J. Variation in early developmental course in autism and its relation with behavioral outcome at 3–4 years of age. *J Autism Dev Disord* 2005;**35**:337–50. http://dx.doi.org/10.1007/s10803-005-3301-6

317. Rogers SJ, Estes A, Lord C, Vismara L, Winter J, Fitzpatrick A, *et al.* Effects of a brief Early Start Denver Model (ESDM)-based parent intervention on toddlers at risk for autism spectrum disorders: a randomized controlled trial. *J Am Acad Child Adolesc Psychiatry* 2012;**51**:1052–65. http://dx.doi.org/10.1016/j.jaac.2012.08.003

318. Aldred C, Green J, Adams C. A new social communication intervention for children with autism: pilot randomised controlled treatment study suggesting effectiveness. *J Child Psychol Psychiatry* 2004;**45**:1420–30. http://dx.doi.org/10.1111/j.1469-7610.2004.00338.x

319. Aldred C, Green J, Emsley R, McConachie H. Mediation of treatment effect in a communication intervention for pre-school children with autism. *J Autism Dev Disord* 2012;**42**:447–54. http://dx.doi.org/10.1007/s10803-011-1248-3

320. Ben Itzchak E, Zachor DA. Who benefits from early intervention in autism spectrum disorders? *Res Autism Spect Disord* 2011;**5**:345–50. http://dx.doi.org/10.1016/j.rasd.2010.04.018

321. Dawson G, Rogers S, Munson J, Smith M, Winter J, Greenson J, *et al.* Randomized, controlled trial of an intervention for toddlers with autism: the Early Start Denver Model. *Pediatrics* 2010;**125**:e17–23. http://dx.doi.org/10.1542/peds.2009-0958

322. Gotham K, Pickles A, Lord C. Trajectories of autism severity in children using standardized ADOS scores. *Pediatrics* 2012;**130**:e1278–84. http://dx.doi.org/10.1542/peds.2011-3668

323. Hartley SLS, D. M. Sex differences in autism spectrum disorder: an examination of developmental functioning, autistic symptoms, and coexisting behavior problems in toddlers. *J Autism Dev Disord* 2009;**39**:1715–22. http://dx.doi.org/10.1007/s10803-009-0810-8

324. Landa RJK, Luther G. Long-term outcomes of toddlers with autism spectrum disorders exposed to short-term intervention. *Pediatrics* 2012;**130**(Suppl. 2):S186–90. http://dx.doi.org/10.1542/peds.2012-0900Q

325. Lerna A, Esposito D, Conson M, Russo L, Massagli A. Social-communicative effects of the Picture Exchange Communication System (PECS) in autism spectrum disorders. *Int J Lang Commun Disord* 2012;**47**:609–17. http://dx.doi.org/10.1111/j.1460-6984.2012.00172.x

326. Oosterling I, Visser J, Swinkels S, Rommelse N, Donders R, Woudenberg T, *et al.* Randomized controlled trial of the focus parent training for toddlers with autism: 1-year outcome. *J Autism Dev Disord* 2010;**40**:1447–58. http://dx.doi.org/10.1007/s10803-010-1004-0

327. Ray-Subramanian CE, Huai N, Weismer SE. Adaptive behavior and cognitive skills for toddlers on the autism spectrum. *J Autism Dev Disord* 2011;**41**:679–84. http://dx.doi.org/10.1007/s10803-010-1083-y

328. Ray-Subramanian CE, Ellis Weismer S. Receptive and expressive language as predictors of restricted and repetitive behaviors in young children with autism spectrum disorders. *J Autism Dev Disord* 2012;**42**:2113–20. http://dx.doi.org/10.1007/s10803-012-1463-6

329. Strauss K, Vicari S, Valeri G, D'Elia L, Arima S, Fava L. Parent inclusion in Early Intensive Behavioral Intervention: the influence of parental stress, parent treatment fidelity and parent-mediated generalization of behavior targets on child outcomes. *Res Dev Disabil* 2012;**33**:688–703. http://dx.doi.org/10.1016/j.ridd.2011.11.008

330. Sullivan M, Finelli J, Marvin A, Garrett-Mayer E, Bauman M, Landa R. Response to joint attention in toddlers at risk for autism spectrum disorder: a prospective study. *J Autism Dev Disord* 2007;**37**:37–48. http://dx.doi.org/10.1007/s10803-006-0335-3

331. Tek S, Landa RJ. Differences in autism symptoms between minority and non-minority toddlers. *J Autism Dev Disord* 2012;**42**:1967–73. http://dx.doi.org/10.1007/s10803-012-1445-8

332. Ventola P, Kleinman J, Pandey J, Wilson L, Esser E, Boorstein H, *et al.* Differentiating between autism spectrum disorders and other developmental disabilities in children who failed a screening instrument for ASD. *J Autism Dev Disord* 2007;**37**:425–36. http://dx.doi.org/10.1007/s10803-006-0177-z

333. Wong VCN, Kwan QK. Randomized controlled trial for early intervention for autism: a pilot study of the Autism 1–2–3 Project. *J Autism Dev Disord* 2010;**40**:677–88. http://dx.doi.org/10.1007/s10803-009-0916-z

334. Zachor D, Ben Itzchak E, Rabinovich A-L, Lahat E. Change in autism core symptoms with intervention. *Res Autism Spect Disord* 2006;**1**:304–17. http://dx.doi.org/10.1016/j.rasd.2006.12.001

335. Zachor DA, Itzchak EB. Treatment approach, autism severity and intervention outcomes in young children. *Res Autism Spect Disord* 2010;**4**:425–32. http://dx.doi.org/10.1016/j.rasd.2009.10.013

336. Fodstad JC, Matson JL, Hess J, Neal D. Social and communication behaviours in infants and toddlers with autism and pervasive developmental disorder-not otherwise specified. *Dev Neurorehabil* 2009;**12**:152–7. http://dx.doi.org/10.1080/17518420902936748

337. Receveur C, Lenoir P, DeSombre H, Roux S, Barthelemy C, Malvy J. Interaction and imitation deficits from infancy to 4 years of age in children with autism: a pilot study based on videotapes. *Autism* 2005;**9**:69–82. http://dx.doi.org/10.1177/1362361305049030

338. Maestro S, Muratori F, Cesari A, Cavallaro MC, Paziente A, Pecini C, *et al.* Course of autism signs in the first year of life. *Psychopathology* 2005;**38**:26–31. http://dx.doi.org/10.1159/000083967

339. Baghdadli A, Assouline B, Sonie S, Pernon E, Darrou C, Michelon C, *et al.* Developmental trajectories of adaptive behaviors from early childhood to adolescence in a cohort of 152 children with autism spectrum disorders. *J Autism Dev Disord* 2012;**42**:1314–25. http://dx.doi.org/10.1007/s10803-011-1357-z

340. Bopp KD, Mirenda P, Zumbo BD. Behavior predictors of language development over 2 years in children with autism spectrum disorders. *J Speech Lang Hear Res* 2009;**52**:1106–20. http://dx.doi.org/10.1044/1092-4388(2009/07-0262)

341. Jonsdottir SL, Saemundsen E, Asmundsdottir G, Hjartardottir S, Asgeirsdottir BB, Smaradottir HH, *et al.* Follow-up of children diagnosed with pervasive developmental disorders: stability and change during the preschool years. *J Autism Dev Disord* 2007;**37**:1361–74. http://dx.doi.org/10.1007/s10803-006-0282-z

342. Malhi P, Singhi P. Follow up of children with autism spectrum disorders: stability and change in diagnosis. *Indian J Pediatr* 2011;**78**:941–5. http://dx.doi.org/10.1007/s12098-011-0370-8

343. Pajareya K, Nopmaneejumruslers K. A one-year prospective follow-up study of a DIR/Floortime parent training intervention for pre-school children with autistic spectrum disorders. *J Med Assoc Thailand* 2012;**95**:1184–93.

344. Pajareya K, Nopmaneejumruslers K. A pilot randomized controlled trial of DIR/Floortime™ parent training intervention for pre-school children with autistic spectrum disorders. *Autism* 2011;**15**:563–77. http://dx.doi.org/10.1177/1362361310386502

345. Papavasiliou AS, Nikaina I, Rizou J, Alexandrou S. The effect of a psycho-educational program on CARS scores and short sensory profile in autistic children. *Eur J Paediatr Neurol* 2011;**15**:338–44. http://dx.doi.org/10.1016/j.ejpn.2011.02.004

346. Stone WL, Ousley OY, Hepburn SL, Hogan KL, Brown CS. Patterns of adaptive behavior in very young children with autism. *Am J Ment Retard* 1999;**104**:187–99. http://dx.doi.org/10.1352/0895-8017(1999)104<0187:POABIV>2.0.CO;2

347. Vorgraft Y, Farbstein I, Spiegel R, Apter A. Retrospective evaluation of an intensive method of treatment for children with pervasive developmental disorder. *Autism* 2007;**11**:413–24. http://dx.doi.org/10.1177/1362361307079605

348. Cassidy A, McConkey R, Truesdale-Kennedy M, Slevin E. Preschoolers with autism spectrum disorders: the impact on families and the supports available to them. *Early Child Dev Care* 2008;**178**:115–28. http://dx.doi.org/10.1080/03004430701491721

349. McConkey R, Truesdale-Kennedy M, Crawford H, McGreevy E, Reavey M, Cassidy A. Preschoolers with autism spectrum disorders: evaluating the impact of a home-based intervention to promote their communication. *Early Child Dev Care* 2010;**180**:299–315. http://dx.doi.org/10.1080/03004430801899187

350. Osborne LA, McHugh L, Saunders J, Reed P. Parenting stress reduces the effectiveness of early teaching interventions for autistic spectrum disorders. *J Autism Dev Disord* 2008;**38**:1092–103. http://dx.doi.org/10.1007/s10803-007-0497-7

351. Osborne LA, Reed P. The relationship between parenting stress and behavior problems of children with autistic spectrum disorders. *Except Child* 2009;**76**:54–73.

352. Reed P, Osborne LA, Corness M. Brief report: relative effectiveness of different home-based behavioral approaches to early teaching intervention. *J Autism Dev Disord* 2007;**37**:1815–21. http://dx.doi.org/10.1007/s10803-006-0306-8

353. Reed P, Osborne LA, Corness M. The real-world effectiveness of early teaching interventions for children with autism spectrum disorder. *Except Child* 2007;**73**:417–33. http://dx.doi.org/10.1177/001440290707300402

354. Reed P, Osborne L. Impact of severity of autism and intervention time-input on child outcomes: comparison across several early interventions. *Br J Spec Educ* 2012;**39**:130–6. http://dx.doi.org/10.1111/j.1467-8578.2012.00549.x

355. Stahmer AC, Ingersoll B. Inclusive programming for toddlers with autism spectrum disorders: outcomes from the children's toddler school. *J Posit Behav Int* 2004;**6**:67–82. http://dx.doi.org/10.1177/10983007040060020201

356. Eaves RC, Williams TO Jr. Exploratory and confirmatory factor analyses of the pervasive developmental disorders rating scale for young children with autistic disorder. *J Genet Psychol* 2006;**167**:65–92. http://dx.doi.org/10.3200/GNTP.167.1.65-92

357. Eapen V, Črnčec R, Walter A. Clinical outcomes of an early intervention program for preschool children with autism spectrum disorder in a community group setting. *BMC Pediatr* 2013;**13**:3. http://dx.doi.org/10.1186/1471-2431-13-3

358. Remington B, Hastings RP, Kovshoff H, Degli Espinosa F, Jahr E, Brown T, *et al.* Early intensive behavioral intervention: outcomes for children with autism and their parents after two years. *Am J Ment Retard* 2007;**112**:418–38. http://dx.doi.org/10.1352/0895-8017(2007)112[418:EIBIOF]2.0.CO;2

359. Smith IM, Koegel RL, Koegel LK, Openden DA, Fossum KL, Bryson SE. Effectiveness of a novel community-based early intervention model for children with autistic spectrum disorder. *Am J Intellect Dev Disabil* 2010;**115**:504–23. http://dx.doi.org/10.1352/1944-7558-115.6.504

360. Takeda T, Koyama T, Kanai C, Kurita H. Clinical variables at age 2 predictive of mental retardation at age 5 in children with pervasive developmental disorder. *Psychiatry Clin Neurosci* 2005;**59**:717–22. http://dx.doi.org/10.1111/j.1440-1819.2005.01442.x

361. Casenhiser DM, Shanker SG, Stieben J. Learning through interaction in children with autism: preliminary data from a social-communication-based intervention. *Autism* 2013;**17**:220–41. http://dx.doi.org/10.1177/1362361311422052

362. Landa RJ, Holman KC, Garrett-Mayer E. Social and communication development in toddlers with early and later diagnosis of autism spectrum disorders. *Arch Gen Psychiatry* 2007;**64**:853–64. http://dx.doi.org/10.1001/archpsyc.64.7.853

363. Keen D, Couzens D, Muspratt S, Rodger S. The effects of a parent-focused intervention for children with a recent diagnosis of autism spectrum disorder on parenting stress and competence. *Res Autism Spect Disord* 2010;**4**:229–41. http://dx.doi.org/10.1016/j.rasd.2009.09.009

364. Keen D, Rodger S, Doussin K, Braithwaite M. A pilot study of the effects of a social-pragmatic intervention on the communication and symbolic play of children with autism. *Autism* 2007;**11**:63–71. http://dx.doi.org/10.1177/1362361307070901

365. Dereu M, Roeyers H, Raymaekers R, Warreyn P. Exploring individual trajectories of social communicative development in toddlers at risk for autism spectrum disorders. *Res Autism Spect Disord* 2012;**6**:1038–52. http://dx.doi.org/10.1016/j.rasd.2011.12.003

366. Goods KS, Ishijima E, Chang Y-C, Kasari C. Preschool based JASPER intervention in minimally verbal children with autism: pilot RCT. *J Autism Dev Disord* 2013;**43**:1050–6. http://dx.doi.org/10.1007/s10803-012-1644-3

367. Kalas A. Joint Attention responses of children with autism spectrum disorder to simple versus complex music. *J Music Ther* 2012;**49**:430–52. http://dx.doi.org/10.1093/jmt/49.4.430

368. Kasari C, Freeman S, Paparella T. Joint attention and symbolic play in young children with autism: a randomized controlled intervention study. *J Child Psychol Psychiatry* 2006;**47**:611–20. [Erratum appears in *J Child Psychol Psychiatry* 2007;**48**:523.] http://dx.doi.org/10.1111/j.1469-7610.2005.01567.x

369. Lawton K, Kasari C. Brief report: longitudinal improvements in the quality of joint attention in preschool children with autism. *J Autism Dev Disord* 2012;**42**:307–12. http://dx.doi.org/10.1007/s10803-011-1231-z

370. Paparella T, Goods KS, Freeman S, Kasari C. The emergence of nonverbal joint attention and requesting skills in young children with autism. *J Commun Disord* 2011;**44**:569–83. http://dx.doi.org/10.1016/j.jcomdis.2011.08.002

371. Roos EM, McDuffie AS, Weismer SE, Gernsbacher MA. A comparison of contexts for assessing joint attention in toddlers on the autism spectrum. *Autism* 2008;**12**:275–91. http://dx.doi.org/10.1177/1362361307089521

372. Salt J, Shemilt J, Sellars V, Boyd S, Coulson T, McCool S. The Scottish Centre for autism preschool treatment programme. II: The results of a controlled treatment outcome study. *Autism* 2002;**6**:33–46. http://dx.doi.org/10.1177/1362361302006001004

373. Wong CS. A play and joint attention intervention for teachers of young children with autism: a randomized controlled pilot study. *Autism* 2013;**17**:340–57. http://dx.doi.org/10.1177/1362361312474723

374. Yoder P, Stone WL. Randomized comparison of two communication interventions for preschoolers with autism spectrum disorders. *J Consult Clin Psychol* 2006;**74**:426–35. http://dx.doi.org/10.1037/0022-006X.74.3.426

375. Yoder PJ, Lieberman RG. Randomized test of the efficacy of picture exchange communication system on highly generalized picture exchanges in children with ASD. *J Autism Dev Disord* 2010;**40**:629–32. http://dx.doi.org/10.1007/s10803-009-0897-y

376. Ingersoll B. Brief report: pilot randomized controlled trial of reciprocal imitation training for teaching elicited and spontaneous imitation to children with autism. *J Autism Dev Disord* 2010;**40**:1154–60. http://dx.doi.org/10.1007/s10803-010-0966-2

377. Clifford SM, Dissanayake C. The early development of joint attention in infants with autistic disorder using home video observations and parental interview. *J Autism Dev Disord* 2008;**38**:791–805. http://dx.doi.org/10.1007/s10803-007-0444-7

378. Warreyn P, Roeyers H, Van Wetswinkel U, De Groote I. Temporal coordination of joint attention behavior in preschoolers with autism spectrum disorder. *J Autism Dev Disord* 2007;**37**:501–12. http://dx.doi.org/10.1007/s10803-006-0184-0

379. Colgan SE, Lanter E, McComish C, Watson LR, Crais ER, Baranek GT. Analysis of social interaction gestures in infants with autism. *Child Neuropsychol* 2006;**12**:307–19. http://dx.doi.org/10.1080/09297040600701360

380. Ingersoll B, Schreibman L, Stahmer A. Differential treatment outcomes for children with autistic spectrum disorder based on level of peer social avoidance. *J Autism Dev Disord* 2001;**31**:343–9. http://dx.doi.org/10.1023/A:1010703521704

381. Barber AB, Wetherby AM, Chambers NW. Brief report: repetitive behaviors in young children with autism spectrum disorder and developmentally similar peers: a follow up to Watt et al. *J Autism Dev Disord* 2012;**42**:2006–12. http://dx.doi.org/10.1007/s10803-011-1434-3

382. Ben-Sasson A, Cermak SA, Orsmond GI, Tager-Flusberg H, Kadlec MB, Carter AS. Sensory clusters of toddlers with autism spectrum disorders: differences in affective symptoms. *J Child Psychol Psychiatry* 2008;**49**:817–25. http://dx.doi.org/10.1111/j.1469-7610.2008.01899.x

383. Chuang IC, Tseng MH, Lu L, Shieh JY. Sensory correlates of difficult temperament characteristics in preschool children with autism. *Res Autism Spect Disord* 2012;**6**:988–95. http://dx.doi.org/10.1016/j.rasd.2012.01.002

384. Jasmin E, Couture M, McKinley P, Reid G, Fombonne E, Gisel E. Sensori-motor and daily living skills of preschool children with autism spectrum disorders. *J Autism Dev Disord* 2009;**39**:231–41. http://dx.doi.org/10.1007/s10803-008-0617-z

385. Provost B, Crowe TK, Acree K, Osbourn PL, McClain C. Sensory behaviors of preschool children with and without autism spectrum disorders. *NZ J Occup Ther* 2009;**56**:9–17.

386. O'Donnell S, Deitz J, Kartin D, Nalty T, Dawson G. Sensory processing, problem behavior, adaptive behavior, and cognition in preschool children with autism spectrum disorders. *Am J Occup Ther* 2012;**66**:586–94. http://dx.doi.org/10.5014/ajot.2012.004168

387. Tomchek SD, Dunn W. Sensory processing in children with and without autism: a comparative study using the short sensory profile. *Am J Occup Ther* 2007;**61**:190–200. http://dx.doi.org/10.5014/ajot.61.2.190

388. Arick JR, Young HE, Falco RA, Loos LM, Krug DA, Gense MH, *et al.* Designing an outcome study to monitor the progress of students with autism spectrum disorders. *Focus Autism Other Dev Disabil* 2003;**18**:75–87. http://dx.doi.org/10.1177/108835760301800201

389. Bono MA, Daley T, Sigman M. Relations among joint attention, amount of intervention and language gain in autism. *J Autism Dev Disord* 2004;**34**:495–505. http://dx.doi.org/10.1007/s10803-004-2545-x

390. Carlsson LH, Norrelgen F, Kjellmer L, Westerlund J, Gillberg C, Fernell E. Coexisting disorders and problems in preschool children with autism spectrum disorders. *Sci World J* 2013;**2013**:213979. http://dx.doi.org/10.1155/2013/213979

391. Miniscalco C, Franberg J, Schachinger-Lorentzon U, Gillberg C. Meaning what you say? Comprehension and word production skills in young children with autism. *Res Autism Spect Disord* 2012;**6**:204–11. http://dx.doi.org/10.1016/j.rasd.2011.05.001

392. Mitchell S, Brian J, Zwaigenbaum L, Roberts W, Szatmari P, Smith I, *et al.* Early language and communication development of infants later diagnosed with autism spectrum disorder. *J Dev Behav Pediatr* 2006;**27**:S69–78. http://dx.doi.org/10.1097/00004703-200604002-00004

393. Smith V, Mirenda P, Zaidman-Zait A. Predictors of expressive vocabulary growth in children with autism. *J Speech Lang Hear Res* 2007;**50**:149–60. http://dx.doi.org/10.1044/1092-4388(2007/013)

394. Stone WL, Yoder PJ. Predicting spoken language level in children with autism spectrum disorders. *Autism* 2001;**5**:341–61. http://dx.doi.org/10.1177/1362361301005004002

395. Akshoomoff N. Use of the Mullen scales of early learning for the assessment of young children with autism spectrum disorders. *Child Neuropsychol* 2006;**12**:269–77. http://dx.doi.org/10.1080/09297040500473714

396. Anan RM, Warner LJ, McGillivary JE, Chong IM, Hines SJ. Group Intensive Family Training (GIFT) for preschoolers with autism spectrum disorders. *Behav Interv* 2008;**23**:165–80. http://dx.doi.org/10.1002/bin.262

397. Baker JK, Messinger DS, Lyons KK, Grantz CJ. A pilot study of maternal sensitivity in the context of emergent autism. *J Autism Dev Disord* 2010;**40**:988–99. http://dx.doi.org/10.1007/s10803-010-0948-4

398. Barbaro J, Dissanayake C. Developmental profiles of infants and toddlers with autism spectrum disorders identified prospectively in a community-based setting. *J Autism Dev Disord* 2012;**42**:1939–48. http://dx.doi.org/10.1007/s10803-012-1441-z

399. Landa RJ, Gross AL, Stuart EA, Bauman M. Latent class analysis of early developmental trajectory in baby siblings of children with autism. *J Child Psychol Psychiatry* 2012;**53**:986–96. http://dx.doi.org/10.1111/j.1469-7610.2012.02558.x

400. Lloyd M, MacDonald M, Lord C. Motor skills of toddlers with autism spectrum disorders. *Autism* 2013;**17**:133–46. http://dx.doi.org/10.1177/1362361311402230

401. Poon KK, Watson LR, Baranek GT, Poe MD. To what extent do joint attention, imitation, and object play behaviors in infancy predict later communication and intellectual functioning in ASD? *J Autism Dev Disord* 2012;**42**:1064–74. http://dx.doi.org/10.1007/s10803-011-1349-z

402. Schertz HH, Odom SL, Baggett KM, Sideris JH. Effects of joint attention mediated learning for toddlers with autism spectrum disorders: an initial randomized controlled study. *Early Child Res Q* 2013;**28**:249–58. http://dx.doi.org/10.1016/j.ecresq.2012.06.006

403. Siller M, Hutman T, Sigman M. A parent-mediated intervention to increase responsive parental behaviors and child communication in children with ASD: A randomized clinical trial. *J Autism Dev Disord* 2013;**43**:540–55. http://dx.doi.org/10.1007/s10803-012-1584-y

404. Thurm A, Lord C, Lee L-C, Newschaffer C. Predictors of language acquisition in preschool children with autism spectrum disorders. *J Autism Dev Disord* 2007;**37**:1721–34. http://dx.doi.org/10.1007/s10803-006-0300-1

405. Roberts J, Williams K, Carter M, Evans D, Parmenter T, Silove N, *et al.* A randomised controlled trial of two early intervention programs for young children with autism: centre-based with parent program and home-based. *Res Autism Spect Disord* 2011;**5**:1553–66. http://dx.doi.org/10.1016/j.rasd.2011.03.001

406. Flippin M, Watson LR. Relationships between the responsiveness of fathers and mothers and the object play skills of children with autism spectrum disorders. *J Early Interv* 2011;**33**:220–34. http://dx.doi.org/10.1177/1053815111427445

407. Haebig E, McDuffie A, Weismer SE. The contribution of two categories of parent verbal responsiveness to later language for toddlers and preschoolers on the autism spectrum. *Am J Speech Lang Pathol* 2013;**22**:57–70. http://dx.doi.org/10.1044/1058-0360(2012/11-0004)

408. Harris SL, Handleman JS, Gordon R, Kristoff B, Fuentes F. Changes in cognitive and language functioning of preschool children with autism. *J Autism Dev Disord* 1991;**21**:281–90. http://dx.doi.org/10.1007/BF02207325

409. Andersson GW, Gillberg C, Miniscalco C. Pre-school children with suspected autism spectrum disorders: do girls and boys have the same profiles? *Res Dev Disabil* 2013;**34**:413–22. http://dx.doi.org/10.1016/j.ridd.2012.08.025

410. Eikeseth S, Hayward D, Gale C, Gitlesen J-P, Eldevik S. Intensity of supervision and outcome for preschool aged children receiving early and intensive behavioral interventions: a preliminary study. *Res Autism Spect Disord* 2009;**3**:67–73. http://dx.doi.org/10.1016/j.rasd.2008.04.003

411. Herring S, Gray K, Taffe J, Tonge B, Sweeney D, Einfeld S. Behaviour and emotional problems in toddlers with pervasive developmental disorders and developmental delay: Associations with parental mental health and family functioning. *J Intellect Disabil Res* 2006;**50**:874–82. http://dx.doi.org/10.1111/j.1365-2788.2006.00904.x

412. Sheinkopf SJ, Mundy P, Oller DK, Steffens M. Vocal atypicalities of preverbal autistic children. *J Autism Dev Disord* 2000;**30**:345–54. http://dx.doi.org/10.1023/A:1005531501155

413. Smith T, Groen AD, Wynn JW. Randomized trial of intensive early intervention for children with pervasive developmental disorder. *Am J Ment Retard* 2000;**105**:269–85. http://dx.doi.org/10.1352/0895-8017(2000)105<0269:RTOIEI=2.0.CO;2

414. Eldevik S, Hastings RP, Jahr E, Hughes JC. Outcomes of behavioral intervention for children with autism in mainstream pre-school settings. *J Autism Dev Disord* 2012;**42**:210–20. http://dx.doi.org/10.1007/s10803-011-1234-9

415. Eriksson MA, Westerlund J, Hedvall A, Amark P, Gillberg C, Fernell E. Medical conditions affect the outcome of early intervention in preschool children with autism spectrum disorders. *Eur Child Adolesc Psychiatry* 2013;**22**:23–33. http://dx.doi.org/10.1007/s00787-012-0312-7

416. Gabriels R, Ivers BJ, Hill DE, Agnew JA, McNeill J. Stability of adaptive behaviors in middle-school children with autism spectrum disorders. *Res Autism Spect Disord* 2007;**1**:291–303. http://dx.doi.org/10.1016/j.rasd.2006.11.004

417. Grindle CF, Hastings RP, Saville M, Hughes CJ, Huxley K, Kovshoff H, *et al.* Outcomes of a behavioral education model for children with autism in a mainstream school setting. *Behav Modif* 2012;**36**:298–319. http://dx.doi.org/10.1177/0145445512441199

418. Hedvall A, Fernell E, Holm A, Johnels JA, Gillberg C, Billstedt E. Autism, processing speed, and adaptive functioning in preschool children. *Sci World J* 2013;**2013**:158263. http://dx.doi.org/10.1155/2013/158263

419. Klintwall L, Eikeseth S. Number and controllability of reinforcers as predictors of individual outcome for children with autism receiving early and intensive behavioral intervention: a preliminary study. *Res Autism Spect Disord* 2012;**6**:493–9. http://dx.doi.org/10.1016/j.rasd.2011.07.009

420. Munson J, Dawson G, Abbott R, Faja S, Webb SJ, Friedman SD, *et al.* Amygdalar volume and behavioral development in autism. *Arch Gen Psychiatry* 2006;**63**:686–93. http://dx.doi.org/10.1001/archpsyc.63.6.686

421. Peters-Scheffer N, Didden R, Mulders M, Korzilius H. Low intensity behavioral treatment supplementing preschool services for young children with autism spectrum disorders and severe to mild intellectual disability. *Res Dev Disabil* 2010;**31**:1678–84. http://dx.doi.org/10.1016/j.ridd.2010.04.008

422. Restall G, Magill-Evans J. Play and preschool children with autism. *Am J Occupat Ther* 1994;**48**:113–20. http://dx.doi.org/10.5014/ajot.48.2.113

423. Rickards AL, Walstab JE, Wright-Rossi RA, Simpson J, Reddihough DS. One-year follow-up of the outcome of a randomized controlled trial of a home-based intervention programme for children with autism and developmental delay and their families. *Child Care Health Dev* 2009;**35**:593–602. http://dx.doi.org/10.1111/j.1365-2214.2009.00953.x

424. Ruble L, McDuffie A, King AS, Lorenz D. Caregiver responsiveness and social interaction behaviors of young children with autism. *Topics Early Child Spec Educ* 2008;**28**:158–70. http://dx.doi.org/10.1177/0271121408323009

425. Tonge B, Brereton A, Kiomall M, Mackinnon A, Rinehart NJ. A randomised group comparison controlled trial of 'preschoolers with autism': a parent education and skills training intervention for young children with autistic disorder. *Autism* 2014;**18**:166–77. http://dx.doi.org/10.1177/1362361312458186

426. VanMeter L, Fein D, Morris R, Waterhouse L, Allen D. Delay versus deviance in autistic social behavior. *J Autism Dev Disord* 1997;**27**:557–69. http://dx.doi.org/10.1023/A:1025830110640

427. Goin-Kochel RP, Myers BJ, Hendricks DR, Carr SE, Wiley SB. Early responsiveness to intensive behavioural intervention predicts outcomes among preschool children with autism. *Int J Disabil Dev Educ* 2007;**54**:151–75. http://dx.doi.org/10.1080/10349120701330404

428. Yoder P, Stone WL. A randomized comparison of the effect of two prelinguistic communication interventions on the acquisition of spoken communication in preschoolers with ASD. *J Speech Lang Hear Res* 2006;**49**:698–711. http://dx.doi.org/10.1044/1092-4388(2006/051)

429. Sheinkopf SJ, Siegel B. Home-based behavioral treatment of young children with autism. *J Autism Dev Disord* 1998;**28**:15–23. http://dx.doi.org/10.1023/A:1026054701472

430. Smith T, Eikeseth S, Klevstrand M, Lovaas OI. Intensive behavioral treatment for preschoolers with severe mental retardation and pervasive developmental disorder. *Am J Ment Retard* 1997;**102**:238–49. http://dx.doi.org/10.1352/0895-8017(1997)102<0238:IBTFPW>2.0.CO;2

431. Jahromi LB, Bryce CI, Swanson J. The importance of self-regulation for the school and peer engagement of children with high-functioning autism. *Res Autism Spect Disord* 2013;**7**:235–46. http://dx.doi.org/10.1016/j.rasd.2012.08.012

432. Delmolino LM. Brief Report: use of DQ for estimating cognitive ability in young children with autism. *J Autism Dev Disord* 2006;**36**:959–63. http://dx.doi.org/10.1007/s10803-006-0133-y

433. Harris SLH, J.S. Age and IQ at intake as predictors of placement for young children with autism: a four- to six-year follow-up. *J Autism Dev Disord* 2000;**30**:137–42. http://dx.doi.org/10.1023/A:1005459606120

434. Hill-Chapman CR, Herzog TK, Maduro RS. Aligning over the child: parenting alliance mediates the association of autism spectrum disorder atypicality with parenting stress. *Res Dev Disabil* 2013;**34**:1498–504. http://dx.doi.org/10.1016/j.ridd.2013.01.004

435. Meek SE, Robinson LT, Jahromi LB. Parent-child predictors of social competence with peers in children with and without autism. *Res Autism Spect Disord* 2012;**6**:815–23. http://dx.doi.org/10.1016/j.rasd.2011.11.001

436. Taylor JL, Warren ZE. Maternal depressive symptoms following autism spectrum diagnosis. *J Autism Dev Disord* 2012;**42**:1411–18. http://dx.doi.org/10.1007/s10803-011-1375-x

437. Reed P, Osborne LA. The role of parenting stress in discrepancies between parent and teacher ratings of behavior problems in young children with autism spectrum disorder. *J Autism Dev Disord* 2013;**43**:471–7. http://dx.doi.org/10.1007/s10803-012-1594-9

438. Travers JC, Higgins K, Pierce T, Boone R, Miller S, Tandy R. Emergent literacy skills of preschool students with autism: a comparison of teacher-led and computer-assisted instruction. *Educ Train Autism Dev Disabil* 2011;**46**:326–38.

439. Davis TE, Fodstad JC, Jenkins WS, Hess JA, Moree BN, Dempsey T, *et al.* Anxiety and avoidance in infants and toddlers with autism spectrum disorders: evidence for differing symptom severity and presentation. *Res Autism Spect Disord* 2010;**4**:305–13. http://dx.doi.org/10.1016/j.rasd.2009.10.002

440. Ozonoff S, Young GS, Goldring S, Greiss-Hess L, Herrera AM, Steele J, *et al.* Gross motor development, movement abnormalities, and early identification of autism. *J Autism Dev Disord* 2008;**38**:644–56. http://dx.doi.org/10.1007/s10803-007-0430-0

441. Provost B, Heimerl S, Lopez BR. Levels of gross and fine motor development in young children with autism spectrum disorder. *Phys Occupat Ther Pediatr* 2007;**27**:21–36. http://dx.doi.org/10.1080/J006v27n03_03

442. Meirsschaut M, Roeyers H, Warreyn P. The social interactive behaviour of young children with autism spectrum disorder and their mothers: is there an effect of familiarity of the interaction partner? *Autism* 2011;**15**:43–64. http://dx.doi.org/10.1177/1362361309353911

443. Freeman S, Kasari C. Parent–child interactions in autism: characteristics of play. *Autism* 2013;**17**:147–61. http://dx.doi.org/10.1177/1362361312469269

444. Christensen L, Hutman T, Rozga A, Young GS, Ozonoff S, Rogers SJ, *et al.* Play and developmental outcomes in infant siblings of children with autism. *J Autism Dev Disord* 2010;**40**:946–57. http://dx.doi.org/10.1007/s10803-010-0941-y

445. Rojahn J, Matson JL, Mahan S, Fodstad JC, Knight C, Sevin JA, *et al.* Cutoffs, norms, and patterns of problem behaviors in children with an ASD on the Baby and Infant Screen for Children with aUtIsm Traits (BISCUIT-Part 3). *Res Autism Spect Disord* 2009;**3**:989–98. http://dx.doi.org/10.1016/j.rasd.2009.06.002

446. Robbins FR, Dunlap G. Effects of task difficulty on parent teaching skills and behavior problems of young children with autism. *Am J Ment Retard* 1992;**96**:631–43.

447. Reese RM, Richman DM, Belmont JM, Morse P. Functional characteristics of disruptive behavior in developmentally disabled children with and without autism. *J Autism Dev Disord* 2005;**35**:419–28. http://dx.doi.org/10.1007/s10803-005-5032-0

448. Bryce CI, Jahromi LB. Brief report: compliance and noncompliance to parental control strategies in children with high-functioning autism and their typical peers. *J Autism Dev Disord* 2013;**43**:236–43. http://dx.doi.org/10.1007/s10803-012-1564-2

449. Brisson J, Warreyn P, Serres J, Foussier S, Adrien-Louis J. Motor anticipation failure in infants with autism: a retrospective analysis of feeding situations. *Autism* 2012;**16**:420–9. http://dx.doi.org/10.1177/1362361311423385

450. Schwartz IS, Sandall SR, McBride BJ, Boulware G-L. Project DATA (Developmentally Appropriate Treatment for Autism). An inclusive school-based approach to educating young children with autism. *Topics Early Child Spec Educ* 2004;**24**:156–68. http://dx.doi.org/10.1177/02711214040240030301

451. Virues-Ortega J, Rodriguez V, Yu CT. Prediction of treatment outcomes and longitudinal analysis in children with autism undergoing intensive behavioral intervention. *Int J Clin Health Psychol* 2013;**13**:91–100. http://dx.doi.org/10.1016/S1697-2600(13)70012-7

452. Hsieh Y-L, Lo J-L. Occupational experiences and subjective well-being of mothers of children with ASD in Taiwan. *Occupat Ther Int* 2013;**20**:45–53. http://dx.doi.org/10.1002/oti.1339

453. Ozonoff S, Cathcart K. Effectiveness of a home program intervention for young children with autism. *J Autism Dev Disord* 1998;**28**:25–32. http://dx.doi.org/10.1023/A:1026006818310

454. Trad PV, Bernstein D, Shapiro T, Hertzig M. Assessing the relationship between affective responsivity and social interaction in children with pervasive developmental disorder. *J Autism Dev Disord* 1993;**23**:361–77. http://dx.doi.org/10.1007/BF01046225

455. Davis NO, Carter AS. Parenting stress in mothers and fathers of toddlers with autism spectrum disorders: associations with child characteristics. *J Autism Dev Disord* 2008;**38**:1278–91. http://dx.doi.org/10.1007/s10803-007-0512-z

456. Tonge B, Brereton A, Kiomall M, Mackinnon A, King N, Rinehart N. Effects on parental mental health of an education and skills training program for parents of young children with autism: a randomized controlled trial. *J Am Acad Child Adolesc Psychiatry* 2005;**45**:561–9. http://dx.doi.org/10.1097/01.chi.0000205701.48324.26

457. Baker-Ericzen MJ, Brookman-Frazee L, Stahmer A. Stress levels and adaptability in parents of toddlers with and without autism spectrum disorders. *Res Pract Persons Severe Disabil* 2005;**30**:194–204. http://dx.doi.org/10.2511/rpsd.30.4.194

458. Bendixen RM, Elder JH, Donaldson S, Kairalla JA, Valcante G, Ferdig RE. Effects of a father-based in-home intervention on perceived stress and family dynamics in parents of children with autism. *Am J Occup Ther* 2011;**65**:679–87. http://dx.doi.org/10.5014/ajot.2011.001271

459. Minjarez MB, Mercier EM, Williams SE, Hardan AY. Impact of pivotal response training group therapy on stress and empowerment in parents of children with autism. *J Posit Behav Interv* 2013;**15**:71–8. http://dx.doi.org/10.1177/1098300712449055

460. Wang J, Hu YJ, Wang Y, Qin XQ, Xia W, Sun CH, *et al.* Parenting stress in Chinese mothers of children with autism spectrum disorders. *Soc Psychiatry Psychiatric Epidemiol* 2013;**48**:575–82. http://dx.doi.org/10.1007/s00127-012-0569-7

461. Oppenheim D, Koren-Karie N, Dolev S, Yirmiya N. Maternal sensitivity mediates the link between maternal insightfulness/resolution and child–mother attachment: The case of children with Autism Spectrum Disorder. *Attach Hum Dev* 2012;**14**:567–84. http://dx.doi.org/10.1080/14616734.2012.727256

462. Wachtel K, Carter AS. Reaction to diagnosis and parenting styles among mothers of young children with ASDs. *Autism* 2008;**12**:575–94. http://dx.doi.org/10.1177/1362361308094505

463. Farmer J, Reupert A. Understanding autism and understanding my child with autism: an evaluation of a group parent education program in rural Australia. *Aust J Rural Health* 2013;**21**:20–7. http://dx.doi.org/10.1111/ajr.12004

464. Terwee CB, Mokkink LB, Knol DL, Ostelo RWJG, Bouter LM, De Vet HCW. Rating the methodological quality in systematic reviews of studies on measurement properties: a scoring system for the COSMIN checklist. *Qual Life Res* 2012;**21**:651–7. http://dx.doi.org/10.1007/s11136-011-9960-1

465. Nordin V, Gillberg C, Nyden A. The Swedish version of the Childhood Autism Rating Scale in a clinical setting. *J Autism Dev Disord* 1998;**28**:69–75. http://dx.doi.org/10.1023/A:1026067104198

466. Tachimori H, Osada H, Kurita H. Childhood Autism Rating Scale: Tokyo Version for screening pervasive developmental disorders. *Psychiatry Clin Neurosci* 2003;**57**:113–18. http://dx.doi.org/10.1046/j.1440-1819.2003.01087.x

Appendix 1 Health Technology Assessment Commissioning Brief 11/22

NIHR Health Technology Assessment Programme *HTA no 11/22*

Tools and outcome measures for monitoring autism spectrum disorder

Introduction

The aim of the HTA programme is to ensure that high quality research information on the effectiveness, costs and broader impact of health technologies is produced in the most efficient way for those who use, manage, provide care in or develop policy for the NHS. Topics for research are identified and prioritised to meet the needs of the NHS. Health technology assessment forms a substantial portfolio of work within the National Institute for Health Research and each year about fifty new studies are commissioned to help answer questions of direct importance to the NHS. The studies include both primary research and evidence synthesis.

Question

What is the validity of tools and outcome measures used in measuring and monitoring autism spectrum disorder (ASD); and how well do these reflect and measure issues of importance for patients and carers?

1 **Technology:** Tools for measuring and monitoring aspects of autism (excluding diagnosis).
2 **Patient group:** Children with autism spectrum disorder up to about 6 years old.
3 **Setting:** Any appropriate setting.
4 **Control or comparator treatment:** n/a
5 **Design:** A systematic review of qualitative and quantitative tools and outcome measures used in the assessment and monitoring of children with ASD. The validity of the tools and their sensitivity to change should be assessed, as well as their importance to carers. These findings should inform a discussion about the appropriate choice of tools and identify those elements that appear to be most robust and could best inform the future development of a suite of tools for use in research into the effectiveness of interventions for ASD but potentially also for use in clinical practice.
6 **Important outcomes:** Findings of the systematic reviews, suitability of tools for use in monitoring patients, and research recommendations.

Information for potential applicants:

Autistic spectrum disorder encompasses a wide variety of behavioural and communicative problems. In the UK there are over half a million people with autism - around 1 in 100 people. Yet, it often remains unrecognised and undiagnosed until or after late preschool age. The initial presentation can be to a wide range of professionals in primary care, education or social services. ASD-specific diagnostic instruments may be used to supplement the process of clinical observation, as part of the diagnostic assessment. A wide number of different rating instruments have been developed and some have not been validated. . It would be desirable to have a suite of validated tools with standardised outcome measures for use in clinical practice in the NHS as well as for use in research.

Appendix 2 Scoping review of qualitative literature

Question: What child and/or family specific outcomes do parents of children with ASD perceive as important?

(Christopher Morris, Nuala Livingstone, Bryony Beresford)

Methods

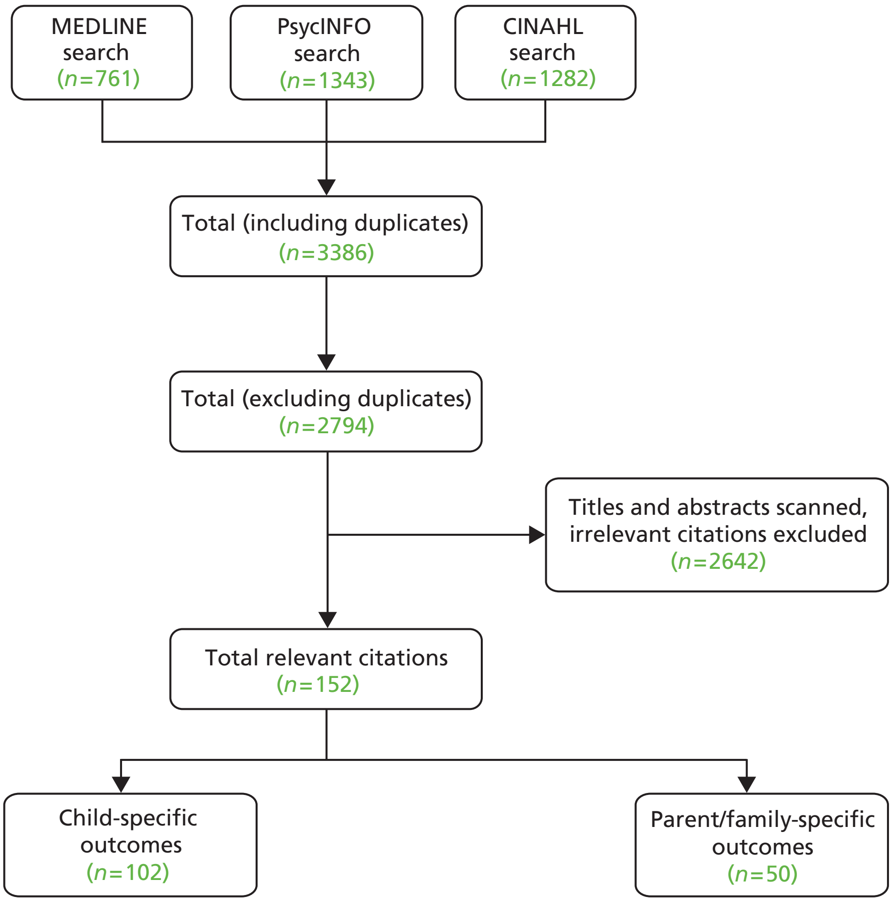
Search strategy

A systematic search was conducted using MEDLINE, CINAHL and PsycINFO (via Ovid). Blocks of search terms were assembled for ASD (block 1) and Qualitative Study Designs (block 2), tailored to each database.

Example of search strategy

Search terms	PsycINFO		
ASD	1	exp Pervasive Developmental Disorders/	21,449
	2	exp Developmental Disabilities/	10,206
	3	autis$.ab,ti.	24,176
	4	asperg$.ab,ti.	2493
	5	pdd.ab,ti.	1192
	6	pervasive developmental disorder$.ab,ti.	2081
	7	kanner$.ab,ti.	345
	8	1 or 2 or 3 or 4 or 5 or 6 or 7	35,627
Qualitative study design	9	((‘semi-structured’ or semistructured or unstructured or informal or ‘in-depth’ or indepth or ‘face-to-face’ or structured or guide) adj3 (interview* or discussion* or questionnaire*)).ab,ti.	49,983
	10	(focus group* or qualitative or ethnograph* or fieldwork or ‘field work’ or ‘key informant’).ab,ti.	95,482
	11	exp Qualitative Research/	3248
	12	exp Interviews/	9745
	13	exp Group Discussion/	3127
	14	exp Narratives/	10,680
	15	(parent$ adj3 priorit$).ab,ti.	104
	16	(desired adj1 outcome$).ab,ti.	849
	17	9 or 10 or 11 or 12 or 13 or 14 or 15 or 16	151,148
	18	8 and 17	1343

Search results



Data extracted from included studies

Author: Auert *et al.*[31]

Title: Parents' Expectations, Awareness, and Experiences of Accessing eVidence-based Speech–Language Pathology Services for Their Children with Autism

Year: 2012

Country: USA

Child age: 3–6 years

Methods: Four focus groups exploring *expectations*, awareness of and experiences with access to speech-and-language therapy services; 20 parents

Notes:

Major themes related to and use of evidence in practice in speech-and-language therapy and parents' expectations of services

No data on *child* outcomes

Data on *parent* outcomes (see below)

Information/communication and feedback	The majority, for example, stated that they would like to receive regular feedback from the speech-and-language therapist regarding their children's progress over time and more input into their children's management: '. . . Most people I find don't get the take home homework and they don't get the "This is where we're up to" . . . mothers need confirmation that things are happening . . . if you had a "Today I saw this and this and next week I'm gonna do X". That'd be so helpful . . .'
Expectations of service	Parents expected the service to: • provide parents with information and research literature • involve parents in decision-making processes • teach parents how to deliver therapies at home

Author: Beresford *et al.*[34]

Title: Desired Outcomes for Children and Adolescents with Autistic Spectrum Disorders

Year: 2006

Country: England

Methods: Semistructured interviews with parents ($n = 25$) and *children and young people with autistic spectrum condition* ($n = 5$) exploring desired outcomes for children's/young people's lives, including maintaining current achievements and hopes and aspirations for future

Notes:

A hierarchy of outcomes identified (see below); aspirations within each of the 'outcome domains' were influenced by the child's age, abilities and the way the features of autism were manifest

Many of the long-term aspirations expressed were dependent on short- or medium-term achievements

Fundamental outcomes need to be achieved if outcomes in terms of skills and abilities and 'life-world' are to be fully attained

No quotes presented in paper but available in full project report

Fundamental	• Physical health • Communication • Mental health • Protection/safety
Skills and abilities	• Self-care • Social skills • Life skills • Academic attainment • Emotional/behavioural maturity
'Life-world'	• Friendships • Interests and activities • Part of the local community • Experiences of success and achievement

Author: Braiden *et al.*[32]

Title: Parents' Experience of the Diagnostic Process for Autistic Spectrum Disorders

Year: 2010

Country: Northern Ireland

Child age: 5–11 years

Method: Face-to-face interviews; indirect data only; interview was biographical

Sample: Eleven mothers

Notes:

Focus on parents' experience of *diagnosis*. Speech-and-language therapy and occupational therapy identified on several occasions as valuable support and intervention for children

No data on child outcomes

Limited data on *parent outcomes*

Being informed	• Parents appeared to accept that their children had to see various professionals but they appeared not to fully understand the multidisciplinary assessment . . . parents noted that a flow chart or diagram detailing the multidisciplinary team and the roles within the team would have been very useful • Parents reported a lack of *co-ordination re-ensuring parents fully informed* about services and other sources of support'
Understanding/ parenting	Parents 'desired information relevant and applicable to their child to assist them in understanding and *making sense of their own child's presentation*'

Author: Little *et al.*[37]

Title: Wonders and Worries of Parenting a Child with Asperger Syndrome and Non-verbal Learning Disorder

Year: 2006

Country: USA

Age: 3–21 years with Asperger syndrome and/or non-verbal learning disorder

Method: Survey instrument with open-ended questions; 103 couples (each completed instrument); qualitative analysis of open-ended questions

Notes: Outcome-related themes listed below: *child and parent outcomes*

Parent outcome: positive times with child	'When he is behaving well and not gearing up for a fight, he's a very happy and pleasant child, whom I can enjoy spending time with and doing things with'
Concerns about adulthood	'Fend for (him or) herself as an adult' 'Lack of friends, uncontrollable temper and frustration, *I just hope he will be able to grow up, get a job, raise a family, live a normal life*' '*Loving relationships outside our family*' 'A proper match between his abilities and living/job situation'
Mental health concerns	One father reported concern that his son '. . . will be *isolated from peers or rejected* (and) will develop *depression and anxiety'* Ability to manage anger and behaviour to avoid getting into trouble
Victimisation concerns	'I worry that he will unknowingly insult someone who will physically retaliate; that *someone will take advantage* of his social deficits and then physically harm him'

Author: Mackintosh *et al.*[36]

Title: 'What Do You Like/dislike About the Treatments You are Currently Using?' A Qualitative Study of Parents of Children with Autism Spectrum Disorders

Year: 2012

Country: USA

Child age: 2–21 years (mean = 8.3 years)

Methods: 'Web-based qualitative study', $n = 486$ parents; 'what do you like/dislike about treatments you are currently using?'

Notes:

Six themes emerged and are discussed: effectiveness of treatments, relationships with professionals, access to treatments, costs, medication concerns and [parents'] stress

Relevant data extracted below

Effective treatments (illustrative quotes to right) identified as yielding the following outcomes:

- Medication does not 'zone out' child or alter behaviour
- Improved behaviour
- Improved attention/behaviour; also supports learning outcomes
- Self-esteem; also supports engagement in other interventions, including education
- Speech
- 'To find the child'
- 'Stress-free' interventions

'*Not "zoned out*" by meds'

'*Do not like the fact he takes regular medication* but at the same time it allows him to function better'

'As for *behavior modifying*, well we will keep on trying till we find one which works'

'Love the diet – makes it *easier for him to learn*'

'She is currently on Adderall. This helps her *to sit still at school and focus longer*. This medicine makes her aggressive at times. When she is not on it, she is silly/slap happy, goofy acting'

Occupational therapy to *improve motor skills* seen to *improve self-esteem* which 'makes him more available to *make improvements in other areas*' (including *learning*)

'To *find the child* and *bring him out*'

'Speech therapy starting at age 2 has had a profound impact and allowed him to finally *develop speech*'

'The most effective therapy we have for him right now is OT [occupational therapy]. This is a very *stress-free therapy* for him, and has helped somewhat in sensory integration'

Author: Serpentine *et al.*[35]

Title: Decision Making of Parents of Children With Autism Spectrum Disorder Concerning Augmentative and Alternative Communication in Hungary

Year: 2010

Country: USA but looking at parental views in *Hungary*

Age: 6–16 years; ASD with no functional communication

Methods: A single focus group and individual interviews are referred to; methods unclear; focus of interviews was experiences of augmentative and alternative communications

Notes:

Six main themes emerged from the data. These included:
(a) sources of information
(b) interventions to support communication
(c) intervention outcomes (see below)
(d) reasons for adding interventions
(e) reasons for discontinuing interventions
(f) desired interventions
(g) decision-making processes

Development of natural speech	'That his speech would develop, that he would probably start speaking, say words'
Improved communication (parent to child and child to parent)	'We expected *to be able to communicate better with our child*'
Improved attention	'That he would start using words, and that he would pay attention to such things that have not interested him before, or not for a long time'
Improved behaviour	'I was hoping his behaviour would change, in fact that his behaviour would get better' 'We hoped the behaviour problems would end, finally no more tantrums'
Interventions acceptable to the child	'We try things. If he likes it or is willing to accept it we try. If he cries or refuses we rather let it be'

Author: Whitaker *et al.*[33]

Title: Supporting Families of Preschool Children with Autism

Year: 2002

Country: England

Age: Up to ~5 years

Methods: Semistructured interview (*no detail on what this covered*) at time of leaving service (EarlyBird programme, delivered by SEN team in LA); *sample size not reported*; *method of data analysis not reported*

Notes: Mainly focused on parents' experiences of training, some potentially relevant issues regarding *parent outcomes* related to parenting/teaching skills:

- *Strategies* for promoting expressive and receptive communication were next most highly valued
- *Techniques* for engaging their child in interactive play were also valued

Also found:

- It was relatively rare for parents to be setting aside time for direct work on specific targets; in practice, they adopted a much more opportunistic and intuitive approach, with a relatively small number of targets serving to provide a broad orientation during their day-to-day interactions with their children
- The whole notion of setting targets was at odds for one parent, with the values implicit in her holistic approach to her son; *she felt that the emphasis should be on her and her family learning to understand and accommodate his difficulties* and that they had no right to 'impose' (as she termed it) targets

LA, local authority; SEN, special educational needs.

Not qualitative research

Author: Bitterman *et al.*[289]

Title: A National Sample of Preschoolers with Autism Spectrum Disorders: Special Education Services and Parent Satisfaction

Year: 2008

Country: USA

Child age: 3–5 years

Method: Telephone interview with parents ($n = 3104$): service use and satisfaction; teacher questionnaire. This was *not a qualitative study*: EXCLUDE

Author: Callahan *et al.*[290]

Title: Social Validation of Evidence-based Practices in Autism by Parents, Teachers, and Administrators

Year: 2008

Country: USA

Age: Not stated

Method: Survey to identified relative importance of elements of *school-based* autism programme; research instrument developed from literature review of evidence on the effectiveness of existing programmes; survey completed by parents (95), teachers (54); administrators (16)

This was *not a qualitative study*: EXCLUDE

Author: Pituch *et al.*[291]

Title: Parent-reported Treatment Priorities for Children with Autism Spectrum Disorders

Year: 2011

Country: New Zealand

Age: 2–21+ years

Method: Online survey, fixed response, used to identify treatment priorities; 90 parents participated

No qualitative data collected: EXCLUDE

No relevant data on outcomes

Author: Dymond *et al.*[292]

Title: Services for Children With Autism Spectrum Disorders

Year: 2007

Country: USA

Age: 0–22 years

Method: Survey of 783 parents, including some *open-ended questions*

Notes:

Recommendations for improving school and community-based services for ASD

No relevant data about measurement or outcomes

Author: Hackett *et al.*[293]

Title: Parental Perceptions of the Assessment of Autistic Spectrum Disorders in a Tier Three Service

Year: 2009

Country: England

Age: Not reported

Method: Parental questionnaire, self-completed or administered via a phone interview; 40 parents who had recently been through a multiagency ASD assessment

Notes:

Service audit, focus on diagnosis and experience of that process

No relevant data about measurement or outcomes

Author: Read and Schofield[294]

Title: Autism: Are Mental Health Services Failing Children and Parents?

Year: 2010

Notes:

Focus on how CAMHS handles ASD

No relevant data about measurement or outcomes

CAMHS, Child and Adolescent Mental Health Services.

Author: Moore *et al.*[295]

Title: Improving Diagnostic and Assessment Services for Children with Autistic Spectrum Disorders

Year: 1999

Country: Northern Ireland

Age: Not reported

Method: Mixed-methods consultation process involving parents and professionals; concerned with diagnostic and assessment processes; no information on how qualitative elements of data collected and analysed

Notes:

Focus on parents' and professionals' experiences and views to determine recommendations for services

No relevant data about measurement or outcomes

Appendix 3 Additional information on *Chapter 3* search methodology

Autism-related websites searched for grey literature

Autism Education Trust: www.autismeducationtrust.org.uk/

Autism Research Centre: www.autismresearchcentre.com/

Autism Research Institute: www.autism.com/

Autism Society of America: www.autism-society.org/

Autism Speaks: www.autismspeaks.org/

Autism-Europe: www.autismeurope.org/

Interactive Autism Network: www.iancommunity.org/

Research Autism: www.researchautism.net/

UK Autism Foundation: www.ukautismfoundation.org/

List of search terms

Autism terms

ASC

ASD (NOT atrial septal defect)

Asperger*

Autis*

childhood schizophrenia

communicat*

Kanner*

language delay*

PDD

pervasive developmental disorder

speech disorder*

semantic-pragmatic disorder

PDD-NOS

exp Child Development Disorders, Pervasive/ [MeSH]

Age group terms

Child*

elementary (school)

infan*

kindergarten*

nursery

p?ediatric*

pre-school*

preschool*

primary (school)

toddler*

special needs

grammar (school)

exp child/ [MeSH]

Behaviour-related terms

Behavio?r

intervention*

non-verbal

program*

rehabilitat*

social interaction

therap*

train OR training OR trained

treatment*

verbal

Assessment-related terms

Assess*

exam*

feasib*

measur*

method*

questionnaire*

reliab*

repeat*

report*

reproducib*

self-report*

survey*

test*

valid*

score*

diagnostic*

observ*

track*

monitor*

follow-up

scale

outcome*

audit*

record*

Example search strategies

MEDLINE (Ovid)

1. (asd not atrial septal defect).ab,ti.
2. 'Asperger*'.ab,ti.
3. 'Autis*'.ab,ti.
4. childhood schizophrenia.ab,ti.
5. 'Kanner*'.ab,ti.
6. (PDD or PDD-NOS).ab,ti.
7. semantic-pragmatic disorder.ab,ti.
8. 'language delay*'.ab,ti.
9. 'speech disorder*'.ab,ti.
10. pervasive developmental disorder.ab,ti.
11. exp Child Development Disorders, Pervasive/
12. or/1-11
13. exp Child/
14. 'infan*'.ab,ti.
15. 'child*'.ab,ti.
16. 'kindergarten*'.ab,ti.
17. nursery.ab,ti.
18. 'p?ediatric*'.ab,ti.
19. (pre-school* or preschool*).ab,ti.
20. 'toddler*'.ab,ti.
21. special needs.ab,ti.
22. ((primary or elementary or grammar) and school).ab,ti.
23. or/13-22
24. 12 and 23
25. Behavio?r.tw.
26. 'intervention*'.tw.
27. non-verbal.tw.
28. program$4.tw.
29. 'rehabilitat*'.tw.
30. social interaction.tw.
31. 'therap*'.tw.
32. 'treatment*'.tw.
33. verbal.tw.
34. (train or training or trained).tw.
35. or/25-34
36. 24 and 35
37. limit 36 to (english language and humans and yr='1992 -Current')
38. 'assess*'.tw.
39. 'feasib*'.tw.
40. 'measur*'.tw.
41. 'method*'.tw.
42. 'questionnaire*'.tw.
43. 'reliab*'.tw.
44. 'repeat*'.tw.
45. 'report*'.tw.
46. 'reproducib*'.tw.
47. 'self-report*'.tw.
48. 'survey*'.tw.
49. 'valid*'.tw.

50. 'score*'.tw.
51. 'diagnostic*'.tw.
52. 'observ*'.tw.
53. 'track*'.tw.
54. 'monitor*'.tw.
55. follow-up.tw.
56. scale.tw.
57. 'outcome*'.tw.
58. 'audit*'.tw.
59. 'record*'.tw.
60. or/38-59
61. 37 and 60
62. limit 61 to (english language and humans and yr='1992 -Current')
63. Epidemiologic Studies/
64. 62 and 63
65. cohort.ti,ab. or exp Cohort Studies/ or longitudinal.ti,ab. or prospective.ti,ab. or retrospective.ti,ab.
66. 62 and 65
67. exp Clinical Trial/ or double-blind method/ or (clinical trial* or randomized controlled trial or multicenter study).pt. or exp Clinical Trials as Topic/ or ((randomi?ed adj7 trial*) or (controlled adj3 trial*) or (clinical adj2 trial*) or ((single or doubl* or tripl* or treb*) and (blind* or mask*))).ti,ab.
68. limit 67 to yr='1992-2012'
69. 62 and 68
70. ((('semi-structured' or semistructured or unstructured or informal or 'in-depth' or indepth or 'face-to-face' or structured or guide) adj3 (interview* or discussion* or questionnaire*)) or (focus group* or qualitative or ethnograph* or fieldwork or 'field work' or 'key informant')).ti,ab. or interviews as topic/ or focus groups/ or narration/ or qualitative research/
71. 62 and 70
72. ((systematic adj3 literature) or systematic review* or meta-analy* or metaanaly* or 'research synthesis' or ((information or data) adj3 synthesis) or (data adj2 extract*)).ti,ab. or (cinahl or (cochrane adj3 trial*) or embase or medline or psyclit or (psycinfo not 'psycinfo database') or pubmed or scopus or 'sociological abstracts' or 'web of science').ab. or 'cochrane database of systematic reviews'.jn. or ((review adj5 (rationale or evidence)).ti,ab. and review.pt.) or meta-analysis as topic/ or Meta-Analysis.pt.
73. 62 and 72
74. limit 73 to yr='1992 -Current'
75. exp Case-Control Studies/ or Control Groups/ or Matched-Pair Analysis/ or ((case* adj5 control*) or (case adj3 comparison*) or control group*).ti,ab.
76. 62 and 75
77. 64 or 66 or 69 or 71 or 74 or 76

Education Resources Information Center (ProQuest)

S1 SU.EXACT('Pervasive Developmental Disorders')

S2 ab(ASD OR autis* OR asperger* OR kanner*) OR ti(ASD OR autis* OR asperger* OR kanner*)

S3 ab(PDD OR PDD-NOS OR pervasive developmental disorder) OR ti(PDD OR PDD-NOS OR pervasive developmental disorder)

S4 ab(speech disorder* OR language delay*) OR ti(speech disorder* OR language delay*)

S5 ab(childhood schizophrenia OR semantic-pragmatic disorder) OR ti(childhood schizophrenia OR semantic-pragmatic disorder)

S6 S1 OR S2 OR S3 OR S4 OR S5

S7 SU.EXACT('Young Children')

S8 ab(infan* OR child* OR toddler*) OR ti(infan* OR child* OR toddler*)

S9 ab(kindergarten* OR nursery OR pre-school OR preschool) OR ti(kindergarten* OR nursery OR pre-school OR preschool)

S10 ab((primary or elementary or grammar) and school) OR ti((primary or elementary or grammar) and school)

S11 ab(special needs OR pediatric* OR paediatric*) OR ti(special needs OR pediatric* OR paediatric*)

S12 s7 OR s8 OR s9 OR s10 or s11

S13 s6 and s12

S17 intervention* OR program* OR rehabilitat* OR treatment* OR therap*

S18 behaviour OR behavior

S19 non-verbal OR verbal OR social interaction

S20 train OR training OR trained

S21 s17 or s18 or s19 or s20

S22 s13 and s21

S23 assess* OR feasib* OR measur* OR method* OR questionnaire*

S24 reliab* OR repeat* OR reproducib* OR self-report* OR survey*

S25 valid* OR score* OR diagnostic* OR observ* OR track*

S26 monitor* OR follow-up OR scale OR outcome* OR audit* OR record*

S27 s23 or s24 or s25 or s26

S28 s22 and s27

S29 (s22 and s27) AND la.exact('ENG') AND pd(1992-2012)

S30 (s22 and s27) AND peer(yes)

S31 (s22 and s27) AND (peer(yes) AND yr(1990-2019))

S32 (s22 and s27) AND (peer(yes) AND yr(1990-2019))

Web of Science

#1 (TI=((ASD NOT atrial septal defect) OR autis* OR asperger* OR kanner* OR PDD OR PDD-NOS OR pervasive developmental disorder OR speech disorder* OR language delay* OR childhood schizophrenia OR semantic-pragmatic disorder)) AND Language=(English) Databases=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, BKCI-S, BKCI-SSH Timespan=1992-2012 Lemmatization=On

#2 (TI=(infan* OR child* OR toddler* OR kindergarten* OR nursery OR pre-school OR preschool OR ((primary or elementary or grammar) and school) OR special needs OR pediatric* OR paediatric*)) AND Language=(English) Databases=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, BKCI-S, BKCI-SSH Timespan=1992-2012 Lemmatization=On

#3 (#1 AND #2) AND Language=(English) Databases=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, BKCI-S, BKCI-SSH Timespan=1992-2012 Lemmatization=On

#4 (TS=(intervention* OR program* OR rehabilitat* OR treatment* OR therap* OR behaviour OR behavior OR non-verbal OR verbal OR social interaction OR train OR training OR trained)) AND Language=(English) Databases=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, BKCI-S, BKCI-SSH Timespan=1992-2012 Lemmatization=On

#5 (TS=(assess* OR feasib* OR measur* OR method* OR questionnaire* OR reliab* OR repeat* OR reproducib* OR self-report* OR survey* OR valid* OR score* OR diagnostic* OR observ* OR track* OR monitor* OR follow-up OR scale OR outcome* OR audit* OR record*)) AND Language= (English) Databases=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, BKCI-S, BKCI-SSH Timespan=1992-2012 Lemmatization=On

#6 #5 AND #4 AND #3 Databases=SCI-EXPANDED, SSCI, A&HCI, CPCI-S Timespan=1992-2012 Lemmatization=On

#7 (#6) AND Language=(English) Databases=SCI-EXPANDED, SSCI, A&HCI, CPCI-S Timespan=1992-2012 Lemmatization=On

Appendix 4 Stage 2: data extraction tool

Author(s)	
Source (Journal/Conference)	
Year of Study	
Unique Study ID	
Report ID *(if multiple reports of same study are included)*	
Contact Details	

Data Extracted by	
Date of Data Extraction	

Study Eligibility

	Yes/No/Unclear	**Comments**
Type of Study		
Types of Participants		
Types of Measurement		

If study should be 'Excluded', record below the justification for this decision

Study Characteristics

Study Design	
Study Location	

Study Duration	
Attrition Details	
Focus of Intervention *(for trials)*	
Focus of longitudinal assessment *(for observational/epidemiological study)*	
Number of Tools Included in study	

Participant Characteristics

	Intervention Group	**Control Group**
Number of Participants		
Number of Participants with ASD*		
Participants recruited from		
Age *(mean, median, range, etc)*		
Gender of participants *(numbers / %, etc)*		
Specific Diagnosis *(Childhood Autism; Asperger Syndrome; Atypical Autism; Pervasive Developmental Disorder, Not Otherwise Specified)*		
Method of Diagnosis *(DSM-IV; ICD-10; Diagnostic Instrument; Other)*		
Comorbidities *(numbers / %, etc)*		
Additional Comments		

Studies must include at least 50% of children with ASD

Measurement Tool Characteristics

Measurement Tool - #1*	
Name of Tool	
Specific subscales used (if applicable)?	
Method of assessment (*direct measurement, observational, parent/child interview, questionnaire, etc*.)	
How was the tool presented? (*e.g., paper questionnaire, electronic questionnaire, video instructions, etc.)*	
What domain(s) was the tool used to capture?	
Was this the primary outcome for the study?	
By whom was it measured/reported?	
When/how often was it measured/reported?	
Was the tool developed ad hoc for the study?	
Did the study make use of blinded assessment?	
Population for which the tool was designed (*ASD specific, General Childhood measure, etc?)*	
Was the tool modified from its original form for the study (by whom and for what purpose)?	
Additional Comments	

Quality Indicators		
	Yes/No/Unclear	**Evidence Provided** *(including cited sources, means, standard deviations, p-values, etc)*
Does this study provide evidence of the tool's validity in general?		
Does this study provide evidence of the tool's validity with children with ASD?		
Does this study provide evidence of the tool's reliability in general?		
Does this study provide evidence of the tool's responsiveness to change?		

repeat table as necessary for each tool included in the study

Other Relevant Information *E.g., information not reported in paper(s) and obtained through contact with authors?*

References to other studies

Did this study refer to additional potentially eligible trials (published or unpublished) not already identified for this review? If so, give details of reference/contact details.

Appendix 5 Tables of papers and data extracted (see *Chapter 3*)

Data from papers are presented in three sets of tables as follows: pp.179–272 – Tools used (paper, location, study design, study aim); pp. 273–377 – Tools used (participant description); and pp. 378–437 – Tools used (subscales, outcomes measured according to the author).

Chapter 3 Tools used (paper, location, study design, study aim)

Symptom severity	Paper	Location	Study design	Study aim
Autism Behavior Checklist (AuBC)	Bennett 2008[296]	Canada	Longitudinal observational	To explore 'specific language impairment' as a predictor of children's symptom and functional outcome
	Gupta 2009[297]	India	Cross-sectional observational	To understudy the development of language and learning skills in children with autism and compare with that of typically developing children
	Jocelyn 1998[298]	Canada	Intervention RCT	Caregiver-based intervention programme in community day-care centres
	Silva 2007[299]	USA	Intervention RCT	Effectiveness of qigong massage methodology, in treating sensory impairment in young children with autism
	Silva 2008[300]	USA	Intervention RCT	Outcomes of pilot of qigong sensory training programme
	Silva 2009[226]	USA	Intervention RCT	Improvement following a qigong massage intervention
	Silva 2011[301]	USA	Intervention RCT	Dual parent and trainer-delivered qigong massage intervention for measures of autism, abnormal sensory responses and self-regulation
	Szatmari 2000[302]	Canada	Longitudinal observational	Monitoring cognitive and language outcomes of groups of children with autism and Asperger syndrome
	Zhang 2012[303]	China	Intervention quasi-experimental	TEAS was applied to children with autism to assess its therapeutic efficacy
Autism Diagnostic Interview-Revised (ADI-R)	Bennett 2012[304]	Canada	Longitudinal observational	Impact of maternal depression on mother's reports of her child's ASD behaviours
	Ben Itzchak 2008[149]	Israel	Longitudinal observational	To examine the relations between cognition and autism severity, head size and intervention outcome
	Brian 2008[305]	Canada	Longitudinal observational	Assessment of potential behavioural markers of ASD at 18 months in a high-risk cohort of infant siblings of children with ASD

Symptom severity	Paper	Location	Study design	Study aim
	Feldman 2012[104]	Canada	Longitudinal observational	Development and evaluation of a new instrument: POEMS
	Hambly 2012[306]	Canada	Cross-sectional observational	The impact of bilingual exposure on language learning in ASD
	Honey 2008[307]	UK	Longitudinal observational	The study tests the following hypotheses: 1. repetitive behaviour items from the ADI-R will group into four factors as identified in ICD-10 2. children with better ability will have fewer repetitive behaviours than those children with lesser ability 3. children with better ability will demonstrate a different pattern of repetitive behaviours from children with lesser ability 4. repetitive behaviours will increase over time in children with ASD
	Magiati 2007[308]	UK	Longitudinal observational	To provide data on long-term outcome for children with ASD who have received intensive, comprehensive interventions in their preschool years
	Magiati 2011[309]	UK	Longitudinal observational	To provide data on long-term outcome for children with ASD who have received intensive, comprehensive interventions in their preschool years
	Mayo 2013[310]	USA	Other – retrospective observational	This study examined the relationship between age of language acquisition and later functioning in children with ASD
	Mooney 2006[311]	Australia	Cross-sectional observational	Examined whether repetitive behaviours are a feature of autism in children aged < 51 months, independent of chronological or developmental age
	Munson 2008[312]	USA	Cross-sectional observational	Latent class analysis of IQ in ASD
	Ozonoff 2010[313]	USA	Longitudinal observational	'To examine prospectively the emergence of behavioural signs of autism in the first years of life in infants at low and high risk for autism'
	Pry 2005[314]	France, Switzerland, Belgium and Luxembourg	Cross-sectional observational	The relationship between expressive language level and psychological development in children with autism at 5 years of age
	Richler 2007[315]	USA	Longitudinal observational	Examination of RRBs
	Werner 2005[316]	USA	Cross-sectional observational	Describing variations in early course of development

Symptom severity	Paper	Location	Study design	Study aim
Autism Diagnostic Observation Scale-Toddler Module (ADOS-T)	Rogers 2012[317]	USA	Intervention RCT	This study was carried out to examine the efficacy of a 12-week, low-intensity (1 hour/week of therapist contact), parent-delivered intervention for toddlers at risk for ASDs aged 14–24 months and their families
Autism Diagnostic Observation Schedule (ADOS)	Aldred 2004[318]	England	Intervention RCT	'Social communication intervention targeting parental communication'
	Aldred 2012[319]	UK	Other RCT	A mediation analysis aimed at assessing the impact of targeted intervention on autism characteristics
	Ben Itzchak 2008[149]	Israel	Longitudinal observational	To examine the relations between cognition and autism severity, head size and intervention outcome
	Ben Itzchak 2011[320]	Israel	Intervention quasi-experimental	The study explored child and parental characteristics at baseline that may predict outcomes in adaptive skills and acquisition of cognitive gains
	Bennett 2012[304]	Canada	Longitudinal observational	Impact of maternal depression on mother's reports of her child's ASD behaviours
	Brian 2008[305]	Canada	Longitudinal observational	Assessment of potential behavioural markers of ASD at 18 months in a high-risk cohort of infant siblings of children with ASD
	Dawson 2010[321]	USA	Intervention RCT	Efficacy of the ESDM, a comprehensive developmental behavioural intervention, for improving outcomes in ASD toddlers
	Gotham 2012[322]	USA	Longitudinal observational	To plot longitudinal trajectories of ASD severity from early childhood to early adolescence
	Green 2010[253]	UK	Intervention RCT	Early interventions for social communication
	Hartley 2009[323]	USA	Cross-sectional observational	To explore developmental patterns, along gender lines, in children who have autism
	Landa 2012[324]	USA	Intervention quasi-experimental	Comprehensive early intervention
	Lerna 2012[325]	Italy	Intervention RCT	PECS vs. CLT
	Luyster 2008[129]	USA	Cross-sectional observational	To systematically investigate language in toddlers with ASD and to identify early correlates of receptive and expressive language in this population

Symptom severity	Paper	Location	Study design	Study aim
	Munson 2008[312]	USA	Cross-sectional observational	Latent class analysis of IQ in ASD
	Oosterling 2010[326]	The Netherlands	Intervention RCT	Intervention is 'Focus parent training'. Home-based parent training promoting compliance, mutual enjoyment, joint attention and language development
	Ray-Subramanian 2011[327]	USA	Cross-sectional observational	'Their study examined adaptive behaviour and cognitive skills for 125 toddlers on the autism spectrum using the recently updated Vineland-II and Bayley-III'
	Ray-Subramanian 2012[328]	USA	Longitudinal observational	This study examined whether language skills and non-verbal cognitive skills were associated with clinician-observed RRBs in children with ASD
	Strauss 2012[329]	Italy	Intervention quasi-experimental	Influence of parent inclusion in treatment provision on child's progress
	Sullivan 2007[330]	USA	Longitudinal observational	To examine whether RJA was impaired as early as 14 months in children later diagnosed with ASD and whether RJA was an early marker for ASD diagnosis at outcome
	Tek 2012[331]	USA	Cross-sectional observational	To assess whether early symptom presentation differs in toddlers with ASD from ethnic minority vs. non-minority backgrounds
	Ventola 2007[332]	USA	Cross-sectional observational	Behavioural presentation of AD, developmental delay and developmental language disorder
	Werner 2005[316]	USA	Cross-sectional observational	Describing variations in early course of development
	Wong 2010[333]	China	Intervention RCT	To pilot a 2-week 'Autism 1-2-3' early intervention for children with autism and their parents immediately after diagnosis that targeted at (1) eye contact, (2) gesture and (3) vocalisation/words
	Zachor 2006[334]	Israel	Intervention quasi-experimental	To compare the outcome of two centre-based interventions for autism
	Zachor 2010[335]	Israel	Longitudinal observational	To examine the effect of the intervention approach (ABA, eclectic) on outcome in cognitive, language, and adaptive skills and on changes in autism diagnosis categories

Symptom severity	Paper	Location	Study design	Study aim
Autism Observation Scale for Infants (AOSI)	Brian 2008[305]	Canada	Longitudinal observational	Assessment of potential behavioural markers of ASD at 18 months in a high-risk cohort of infant siblings of children with ASD
	Bryson 2008[81]	Canada	Longitudinal observational	Putative signs of autism in infants 6–18 months
Baby and Infant Screen for Children with aUtIsm Traits (BISCUIT-Part 1)	Fodstad 2009[336]	USA	Longitudinal observational	To explore verbal/non-verbal and social skills in infants and toddlers with ASD
Behavioral Summarized Evaluation-Revised (BSE-R)	Receveur 2005[337]	France	Longitudinal observational	Interaction and imitation deficits from infancy to 4 years of age in children with autism
Behavioral Summarized Evaluation (BSE)	Maestro 2005[338]	Italy	Cross-sectional observational	Providing new criteria to describe the early course of ASD
Childhood Autism Rating Scale (CARS)	Baghdadli 2012[339]	France	Longitudinal observational	Developmental trajectory of adaptive behaviours
	Bopp 2009[340]	Canada	Longitudinal observational	Examined the relationship between behaviour and trajectories of vocabulary and language development in young children with autism
	Jonsdottir 2007[341]	Iceland	Longitudinal observational	The purpose of the present study was to describe stability and change of preschool children in Iceland and to contribute to the accumulation of data on outcome in autism
	Malhi 2011[342]	India	Longitudinal observational	To assess diagnostic stability of autism diagnosis in children aged ≤ 3 years
	Mayo 2013[310]	USA	Other – retrospective observational	This study examined the relationship between age of language acquisition and later functioning in children with ASD
	Pajareya 2012[343]	Thailand	Intervention quasi-experimental	Determine the results of 1-year DIR/Floortime™ parent training in developmental stimulation of children with ASD
	Pajareya 2011[344]	Thailand	Intervention RCT	RCT of DIR/Floortime intervention for autistic children
	Papavasiliou 2011[345]	Greece	Longitudinal observational	'This study aimed to investigate the effect of an individually tailored psycho-educational programme for autistic children on the scores of the Childhood Autism Rating Scale (CARS) and the Short Sensory Profile (SSP)'
	Pry 2005[314]	France, Switzerland, Belgium and Luxembourg	Cross-sectional observational	The relationship between expressive language level and psychological development in children with autism at 5 years of age
	Stone 1999[346]	USA	Longitudinal observational	To evaluate the reliability and stability of autism diagnosis in children aged < 3 years of age at diagnosis

Symptom severity	Paper	Location	Study design	Study aim
	Ventola 2007[332]	USA	Cross-sectional observational	Behavioural presentation of AD, developmental delay and developmental language disorder
	Vorgraft 2007[347]	Israel	Cross-sectional observational	Effectiveness of the 'Mifne Centre' approach to PDD
	Zhang 2012[303]	China	Intervention quasi-experimental	TEAS was applied to children with autism to assess its therapeutic efficacy
Gilliam Autism Rating Scale (GARS)	Cassidy 2008[348]	Northern Ireland	Cross-sectional observational	To describe the demographic characteristics of preschoolers and their families; to discover parental perceptions of the child's difficulties; to identify the impact the child has on family life; to outline the supports available to families and those they would like to have
	McConkey 2010[349]	–	Intervention quasi-experimental	Evaluate a home-based intervention for preschool children with a confirmed diagnosis of ASD
	Osborne 2008[350]	UK	Intervention quasi-experimental	There was great heterogeneity among the interventions delivered and so for analysis interventions were categorised into high vs. low intensity
	Osborne 2009[351]	UK	Longitudinal observational	Evaluate relationship between child behaviour problems and parental stress
	Reed 2007[352]	UK	Longitudinal observational	Comparing high- and low-intensity interventions (with comparison of three different types of high-intensity interventions)
	Reed 2007[353]	UK	Longitudinal observational	Compare effectiveness of ABA, special nursery placements and portage; addressing limitations of previous studies by using the same measures at baseline and end point
	Reed 2012[354]	UK	Intervention quasi-experimental	To explore and document the relationships between severity of autism, temporal input of the programme and the outcome effectiveness for a variety of early interventions for children on the autism spectrum. In particular, ABA, special nursery placement, an adaptation of a portage approach for individuals on the autism spectrum, and an eclectic approach developed by a local authority were chosen for study
	Stahmer 2004[355]	USA	Intervention quasi-experimental	To analyse the outcomes for 20 young children with ASD in an inclusive programme for children aged < 3 years

Symptom severity	Paper	Location	Study design	Study aim
Infant Behavioral Summarized Evaluation (IBSE)	Adrien 1992[90]	France	Longitudinal observational	To observe and analyse the evolution of behavioural pathology in autistic children
	Receveur 2005[337]	France	Longitudinal observational	Interaction and imitation deficits from infancy to 4 years of age in children with autism
Modified Checklist for Autism in Toddlers (M-CHAT)	Ventola 2007[332]	USA	Cross-sectional observational	Behavioural presentation of AD, developmental delay and developmental language disorder
Parent Observation of Early Markers Scale (POEMS)	Feldman 2012[104]	Canada	Longitudinal observational	Development and evaluation of a new instrument – POEMS
Pervasive Developmental Disorder Rating Scale (PDDRS)	Eaves 2006[356]	USA	Longitudinal observational	To examine the construct validity of the PDDRS
Pervasive Developmental Disorders Behavior Inventory (PDDBI)	Silva 2009[226]	USA	Intervention RCT	Improvement following a qigong massage intervention
	Silva 2011[301]	USA	Intervention RCT	Dual parent and trainer-delivered qigong massage intervention for measures of autism, abnormal sensory responses and self-regulation
Real Life Rating Scale (Ritvo–Freeman) (RLRS)	Wong 2010[333]	China	Intervention RCT	To pilot a 2-week 'Autism 1-2-3' early intervention for children with autism and their parents immediately after diagnosis that targeted at (1) eye contact, (2) gesture and (3) vocalisation/words
Social Communication Questionnaire (SCQ)	Eapen 2013[357]	Australia	Longitudinal observational	Evaluation of ESDM for preschool-aged children with ASD
	Remington 2007[358]	UK	Intervention quasi-experimental	Comparison of early intensive behavioural interventions and treatment as usual
Social Responsiveness Scale (SRS)	Bennett 2012[304]	Canada	Longitudinal observational	Impact of maternal depression on mother's reports of her child's ASD behaviours
	Hambly 2012[306]	Canada	Cross-sectional observational	The impact of bilingual exposure on language learning in ASD
	Smith 2010[359]	Canada and USA	Intervention quasi-experimental	Effect of a parent training and naturalistic one-to-one behaviour intervention using PRT on language, behaviour and ASD symptoms
Childhood Autism Rating Scale (CARS) – Tokyo version[a]	Takeda 2005[360]	Japan	Longitudinal observational	Clinical variables at age 2 years predictive of mental retardation at age 5 years in children with PDD

ABA, applied behavioural analysis; CLT, Conventional Language Therapy; DIR, Developmental Individual-Difference, Relationship-Based; ESDM, Early Start Denver Model; PECS, Picture Exchange Communication System; PRT, Pivotal Response Treatment; RJA, response to joint attention; TEAS, transcutaneous electrical acupoint stimulation.
a Non-UK.

Social awareness	Paper	Location	Study design	Study aim
Child Behavior Rating Scale (CBRS) (Modified)	Casenhiser 2013[361]	Canada	Longitudinal observational	To assess the impact of an intervention on social interaction and communication in children with ASD
Communication and Symbolic Behavior Scales-Developmental Profile (CSBS–DP)	Green 2010[253]	UK	Intervention RCT	Early interventions for social communication
	Landa 2007[362]	USA	Longitudinal observational	To examine patterns of development from 14–24 months in children with early and later diagnosis of ASDs
	Sullivan 2007[330]	USA	Longitudinal observational	To examine whether RJA was impaired as early as 14 months in children later diagnosed with ASD and whether RJA was an early marker for ASD diagnosis at outcome
	Keen 2010[363]	Australia	Intervention quasi-experimental	To reduce parenting stress and increase parenting competence for families of children within 6 months of receiving an ASD diagnosis
	Keen 2007[364]	Australia	Longitudinal observational	To investigate the effects of the Stronger Families Project on communication and symbolic behaviour of young children with autism and to explore possible correlations between post-intervention changes in children's communication and symbolic behaviour, and child adaptive behaviour, chronological age, maternal stress and sense of parenting competence
Early Social Communication Scale (ESCS)	Dereu 2012[365]	Belgium	Longitudinal observational	Developmental trajectories of joint attention, imitation and pretend play impairments in autism
	Goods 2013[366]	USA	Intervention RCT	JASPER
	Ingersoll 2012[286]	USA	Intervention RCT	Imitation intervention to improve social functioning
	Kaale 2012[288]	Norway	Intervention RCT	To explore effectiveness of parent-mediated and specialist-mediated joint attention intervention
	Kalas 2012[367]	USA	Cross-sectional observational	Joint attention responses to simple vs. complex music
	Kasari 2006[368]	USA	Intervention RCT	The efficacy of targeted interventions of joint attention and symbolic play was explored
	Lawton 2012[369]	USA	Intervention quasi-experimental	Joint attention
	Luyster 2008[129]	USA	Cross-sectional observational	To systematically investigate language in toddlers with ASD and to identify early correlates of receptive and expressive language in this population

Social awareness	Paper	Location	Study design	Study aim
	Paparella 2011[370]	USA	Longitudinal observational	Study 1: Cross-sectional study of profile of emergence of joint attention Study 2: Longitudinal study of emergence of joint attention
	Remington 2007[358]	UK	Intervention quasi-experimental	Comparison of early intensive behavioural interventions and treatment as usual
	Roos 2008[371]	USA	Cross-sectional observational	Comparison of contexts for assessing joint attention in toddlers on the autism spectrum
	Salt 2002[372]	UK	Intervention quasi-experimental	Developmentally based early intervention programme
	Wong 2013[373]	USA	Intervention RCT	The aim of this study was to pilot test a classroom-based intervention focused on facilitating play and joint attention for young children with autism in self-contained special education classrooms
	Yoder 2006[374]	USA	Intervention RCT	Compared the efficacy of two communication interventions (RPMT and PECS) in 36 preschoolers with ASDs
Early Social Communication Scales (ESCS)-Abridged	Yoder 2010[375]	USA	Intervention RCT	Effects of a social communication intervention
Imitation Battery (IB)	Luyster 2008[129]	USA	Cross-sectional observational	To systematically investigate language in toddlers with ASD and to identify early correlates of receptive and expressive language in this population
Imitation Disorders Evaluation (IDE)	Receveur 2005[337]	France	Longitudinal observational	Interaction and imitation deficits from infancy to 4 years of age in children with autism
Motor Imitation Scale (MIS)	Ingersoll 2010[376]	USA	Longitudinal observational	To evaluate the effectiveness of an intervention (RIT) in young children with autism
	Ingersoll 2012[286]	USA	Intervention RCT	Imitation intervention to improve social functioning
Preschool Imitation and Praxis Scale (PIPS)	Dereu 2012[365]	Belgium	Longitudinal observational	Developmental trajectories of joint attention, imitation and pretend play impairments in autism
Pre-Verbal Communication Schedule (PVCS)	Salt 2002[372]	UK	Intervention quasi-experimental	Developmentally based early intervention programme
Social Communication Assessment for Toddlers with Autism (SCATA)	Drew 2007[137]	UK	Longitudinal observational	To describe the SCATA administration and scoring, to examine the pattern of developmental change in two samples of children with autism and PDD and to examine which aspects of early non-verbal communication are most strongly associated with later language outcomes

Social awareness	Paper	Location	Study design	Study aim
Social Communication Behavior Codes	Ozonoff 2010[313]	USA	Longitudinal observational	'To examine prospectively the emergence of behavioural signs of autism in the first years of life in infants at low and high risk for autism'
Parent interview[a]	Clifford 2008[377]	Australia	Cross-sectional observational	Home videos and interviews concerning four time periods: (0–5, 6–11, 12–17, 18–24 months)
Caregiver–child interaction[b]	Kasari 2006[368]	USA	Intervention RCT	The efficacy of targeted interventions of joint attention and symbolic play was explored
Coded observation of joint attention[b]	Warreyn 2007[378]	Belgium	Cross-sectional observational	Joint attention in preschoolers with ASD
Coding of initiation of joint attention[b]	Ingersoll 2012[286]	USA	Intervention RCT	Imitation intervention to improve social functioning
Classroom Observation Measure[b]	Goods 2013[366]	USA	Intervention RCT	JASPER
Examiner Ratings of Social Engagement[b]	Ozonoff 2010[313]	USA	Longitudinal observational	'To examine prospectively the emergence of behavioural signs of autism in the first years of life in infants at low and high risk for autism'
Naturalistic examiner–child play sample[b]	Roos 2008[371]	USA	Cross-sectional observational	Comparison of contexts for assessing joint attention in toddlers on the autism spectrum
Prelinguistic Communication Assessment[b]	Stone 1997[133]	USA	Cross-sectional observational	Assessing non-verbal communication on young children with autism
Preschool teacher–child play[b]	Kaale 2012[288]	Norway	Intervention RCT	To explore effectiveness of parent-mediated and specialist-mediated joint attention-intervention
Unstructured free play with examiner[b]	Lerna 2012[325]	Italy	Intervention RCT	PECS vs. CLT
Unstructured Imitation Assessment[b]	Ingersoll 2012[286]	USA	Intervention RCT	Imitation intervention to improve social functioning
	Ingersoll 2010[376]	USA	Longitudinal observational	To evaluate the effectiveness of an intervention (RIT) in young children with autism
Video coding procedures[b]	Colgan 2006[379]	USA	Longitudinal observational	To examine the frequency, initiation, prompting and diversity of types of gestures used for social interaction purposes
Video observation[b]	Clifford 2008[377]	Australia	Cross-sectional observational	Home videos and interviews concerning four time periods: (0–5, 6–11, 12–17, 18–24 months)
Video rating for expressive speech[b]	Baghdadli 2012[339]	France	Longitudinal observational	Developmental trajectory of adaptive behaviours
Video recording of child in classroom activities[b]	Ingersoll 2001[380]	USA	Longitudinal observational	To identify a behavioural characteristic that may affect the outcome of a particular treatment model

CLT, Conventional Language Therapy; JASPER, Joint Attention Symbolic Play Engagement and Regulation; PECS, Picture Exchange Communication System; RCT, randomised controlled trial; RIT, Reciprocal Imitation Training; RJA, response to joint attention; RPMT, Responsive Education and Prelinguistic Milieu Teaching.
a Tools developed ad hoc.
b Observational coding.

Restricted, repetitive behaviour	Paper	Location	Study design	Study aim
Autism Diagnostic Interview-Revised (ADI-R)	Ben Itzchak 2008[149]	Israel	Longitudinal observational	To examine the relations between cognition and autism severity, head size and intervention outcome
	Bennett 2012[304]	Canada	Longitudinal observational	Impact of maternal depression on mother's reports of her child's ASD behaviours
	Brian 2008[305]	Canada	Longitudinal observational	Assessment of potential behavioural markers of ASD at 18 months in a high-risk cohort of infant siblings of children with ASD
	Feldman 2012[104]	Canada	Longitudinal observational	Development and evaluation of a new instrument – POEMS
	Hambly 2012[306]	Canada	Cross-sectional observational	The impact of bilingual exposure on language learning in ASD
	Honey 2008[307]	UK	Longitudinal observational	The study tests the following specific hypotheses: 1. Repetitive behaviour items from the ADI-R will group into four factors as identified in ICD-10 2. Children with better ability will have fewer repetitive behaviours than those children with lesser ability 3. Children with better ability will demonstrate a different pattern of repetitive behaviours from children with lesser ability 4. Repetitive behaviours will increase over time in children with ASD
	Magiati 2007[308]	UK	Longitudinal observational	To provide data on long-term outcome for children with ASD who have received intensive, comprehensive interventions in their preschool years
	Magiati 2011[309]	UK	Longitudinal observational	To provide data on long-term outcome for children with ASD who have received intensive, comprehensive interventions in their preschool years
	Mayo 2013[310]	USA	Other – retrospective observational	This study examined the relationship between age of language acquisition and later functioning in children with ASD
	Mooney 2006[311]	Australia	Cross-sectional observational	Examined whether repetitive behaviours are a feature of autism in children aged < 51 months, independent of chronological or developmental age
	Munson 2008[312]	USA	Cross-sectional observational	Latent class analysis of IQ in ASD

Restricted, repetitive behaviour	Paper	Location	Study design	Study aim
	Ozonoff 2010[313]	USA	Longitudinal observational	'To examine prospectively the emergence of behavioural signs of autism in the first years of life in infants at low and high risk for autism'
	Pry 2005[314]	France, Switzerland, Belgium and Luxembourg	Cross-sectional observational	The relationship between expressive language level and psychological development in children with autism 5 years of age
	Richler 2007[315]	USA	Longitudinal observational	Examination of RRBs
	Werner 2005[316]	USA	Cross-sectional observational	Describing variations in early course of development
Autism Diagnostic Observation Scale-Toddler Module (ADOS-T)	Rogers 2012[317]	USA	Intervention RCT	This study was carried out to examine the efficacy of a 12-week, low-intensity (1 hour per week of therapist contact), parent-delivered intervention for toddlers at risk for ASDs aged 14–24 months and their families
Autism Diagnostic Observation Schedule-Generic (ADOS-G), modules 1 and 2)	Green 2010[253]	UK	Intervention RCT	Early interventions for social communication
Autism Diagnostic Observation Schedule-Generic (ADOS-G)	Aldred 2004[318]	England	Intervention RCT	'Social communication intervention targeting parental communication'
	Aldred 2012[319]	UK	Other RCT	A mediation analysis aimed at assessing the impact of targeted intervention on autism characteristics
	Ben Itzchak 2008[149]	Israel	Longitudinal observational	To examine the relations between cognition and autism severity, head size and intervention outcome
	Ben Itzchak 2011[320]	Israel	Intervention quasi-experimental	The study explored child and parental characteristics at baseline that may predict outcomes in adaptive skills and acquisition of cognitive gains
	Bennett 2012[304]	Canada	Longitudinal observational	Impact of maternal depression on mother's reports of her child's ASD behaviours
	Brian 2008[305]	Canada	Longitudinal observational	Assessment of potential behavioural markers of ASD at 18 months in a high-risk cohort of infant siblings of children with ASD
	Dawson 2010[321]	USA	Intervention RCT	Efficacy of the ESDM, a comprehensive developmental behavioural intervention, for improving outcomes in ASD toddlers

Restricted, repetitive behaviour	Paper	Location	Study design	Study aim
	Gotham 2012[322]	USA	Longitudinal observational	To plot longitudinal trajectories of ASD severity from early childhood to early adolescence
	Hartley 2009[323]	USA	Cross-sectional observational	To explore developmental patterns, along gender lines, in children who have autism
	Landa 2012[324]	USA	Intervention quasi-experimental	Comprehensive early intervention
	Lerna 2012[325]	Italy	Intervention RCT	PECS vs. CLT
	Luyster 2008[129]	USA	Cross-sectional observational	To systematically investigate language in toddlers with ASD and to identify early correlates of receptive and expressive language in this population
	Munson 2008[312]	USA	Cross-sectional observational	Latent class analysis of IQ in ASD
	Oosterling 2010[326]	The Netherlands	Intervention RCT	Intervention is 'Focus parent training'; home-based parent training promoting compliance, mutual enjoyment, joint attention and language development
	Ray-Subramanian 2011[327]	USA	Cross-sectional observational	'Their study examined adaptive behaviour and cognitive skills for 125 toddlers on the autism spectrum using the recently updated Vineland-II and Bayley-III'
	Ray-Subramanian 2012[328]	USA	Longitudinal observational	This study examined whether language skills and non-verbal cognitive skills were associated with clinician-observed RRBs in children with ASD
	Strauss 2012[329]	Italy	Intervention quasi-experimental	Influence of parent inclusion in treatment provision on child's progress
	Sullivan 2007[330]	USA	Longitudinal observational	To examine whether RJA was impaired as early as 14 months in children later diagnosed with ASD and whether RJA was an early marker for ASD diagnosis at outcome
	Tek 2012[331]	USA	Cross-sectional observational	To assess whether early symptom presentation differs in toddlers with ASD from ethnic minority vs. non-minority backgrounds
	Ventola 2007[332]	USA	Cross-sectional observational	Behavioural presentation of AD, developmental delay and developmental language disorder
	Werner 2005[316]	USA	Cross-sectional observational	Describing variations in early course of development

Restricted, repetitive behaviour	Paper	Location	Study design	Study aim
	Wong 2010[333]	China	Intervention RCT	To pilot a 2-week 'Autism 1-2-3' early intervention for children with autism and their parents immediately after diagnosis that targeted at (1) eye contact, (2) gesture and (3) vocalisation/words
	Zachor 2006[334]	Israel	Intervention quasi-experimental	To compare the outcome of two centre-based intervention for autism
	Zachor 2010[335]	Israel	Longitudinal observational	To examine the effect of the intervention approach (ABA, eclectic) on outcome in cognitive, language, and adaptive skills and on changes in autism diagnosis categories
Repetitive Behavior Scale (RBS)	Dawson 2010[321]	USA	Intervention RCT	Efficacy of the ESDM, a comprehensive developmental behavioural intervention, for improving outcomes in ASD toddlers
Classroom and playground behaviour observations[a]	Escalona 2001[271]	USA	Intervention RCT	To explore the effectiveness of massage therapy on stereotypic behaviour among children diagnosed with autism
Video coding[a]	Barber 2012[381]	USA	Cross-sectional observational	Investigating RSB demonstrated by children with ASD ($n = 50$) and typical development ($n = 50$) matched on developmental age, gender and parents' education level

ABA, applied behavioural analysis; AD, autistic disorder; CLT, Conventional Language Therapy; ESDM, Early Start Denver Model; PECS, Picture Exchange Communication System; RCT, randomised controlled trial; RJA, response to joint attention; RSB, repetitive and stereotyped behaviour.
a Observational coding.

Sensory processing	Paper	Location	Study design	Study aim
Infant/Toddler Sensory Profile (ITSP)	Ben-Sasson 2008[382]	Unclear	Cross-sectional observational	(1) What are the patterns of sensory modulation dimensions of sensory clusters of toddlers with ASDs? (2) Is there a sensory-based subgroup that has higher levels of affective symptoms?
Sense and Self-Regulation Checklist (SSC)	Silva 2009[223]	USA	Intervention RCT	Improvement following a qigong massage intervention
	Silva 2011[301]	USA	Intervention RCT	Dual parent- and trainer-delivered qigong massage intervention for measures of autism, abnormal sensory responses and self-regulation
Sensory Profile (SP)	Chuang 2012[383]	Taiwan	Cross-sectional observational	To explore relationships between sensory processing and a difficult temperament characteristics in children with autism
	Jasmin 2009[384]	Canada	Cross-sectional observational	To determine the impact of sensory–motor DLS on the performance of DLS in preschool children with ASD
	Provost 2009[385]	USA	Cross-sectional observational	Identify differences in sensory behaviours between young children with and without ASDs
	Silva 2007[386]	USA	Intervention RCT	Effectiveness of qigong massage methodology, in treating sensory impairment in young children with autism
	Silva 2008[300]	USA	Intervention RCT	Outcomes of pilot of qigong sensory training programme
Short Sensory Profile (SSP)	O'Donnell 2012[386]	USA	Cross-sectional observational	To explore sensory processing characteristics in preschool-age children with ASDs
	Papavasiliou 2011[345]	Greece	Longitudinal observational	'This study aimed to investigate the effect of an individually tailored psycho-educational programme for autistic children on the scores of the Childhood Autism Rating Scale (CARS) and the Short Sensory Profile (SSP)'
	Tomchek 2007[387]	USA	Cross-sectional observational	Differences in sensory processing between children with ASD and typically developing children

DLS, daily living skills; RCT, randomised controlled trial.

Language	Paper	Location	Study design	Study aim
Autism Screening Instrument for Educational Planning (ASIEP)	Arick 2003[388]	USA	Cross-sectional observational	To track programme implementation variables and outcome data for students with ASDs engaged in school or home programmes
Battelle Developmental Inventory (BDI)	Arick 2003[388]	USA	Cross-sectional observational	To track programme implementation variables and outcome data for students with ASDs engaged in school or home programmes
British Picture Vocabulary Scale	Magiati 2007[308]	UK	Longitudinal observational	To provide data on long-term outcome for children with ASD who have received intensive, comprehensive interventions in their preschool years
	Magiati 2011[309]	UK	Longitudinal observational	To provide data on long-term outcome for children with ASD who have received intensive, comprehensive interventions in their preschool years
Clinical Evaluation of Language Fundamentals-Revised	Bono 2004[389]	USA	Longitudinal observational	Investigate the relationship between amount of intervention and language development in children with autism
Communication and Symbolic Behavior Scales-Developmental Profile (CSBS-DP) Caregiver Questionnaire	Tek 2012[331]	USA	Cross-sectional observational	To assess whether early symptom presentation differs in toddlers with ASD from ethnic minority vs. non-minority backgrounds
Comprehensive Assessment of Spoken Language (CASL)	Casenhiser 2013[361]	Canada	Longitudinal observational	To assess the impact of an intervention on social interaction and communication in children with ASD
Expressive One-Word Picture Vocabulary Test	Arick 2003[388]	USA	Cross-sectional observational	To track programme implementation variables and outcome data for students with ASDs engaged in school or home programmes
	Bopp 2009[340]	Canada	Longitudinal observational	Examine the relationship between behaviour and trajectories of vocabulary and language development in young children with autism
	Magiati 2007[308]	UK	Longitudinal observational	To provide data on long-term outcome for children with ASD who have received intensive, comprehensive interventions in their preschool years
	Magiati 2011[309]	UK	Longitudinal observational	To provide data on long-term outcome for children with ASD who have received intensive, comprehensive interventions in their preschool years

Language	Paper	Location	Study design	Study aim
Illinois Test of Psycholinguistic Abilities	Carlsson 2013[390]	Sweden	Cross-sectional observational	To analyse co-occurring disorders and problems in a representative group of 198 preschool children with ASD
MacArthur Communication Development Inventories (MCDI)	Aldred 2004[318]	England	Intervention RCT	'Social communication intervention targeting parental communication'
	Green 2010[253]	UK	Intervention RCT	Early interventions for social communication
	Hambly 2012[306]	Canada	Cross-sectional observational	The impact of bilingual exposure on language learning in ASD
	Hudry 2010[233]	UK	Cross-sectional observational	Recruited as part of Preschool Autism Communication Trial but this report is on baseline data for only receptive vs. expressive skills
	Luyster 2008[129]	USA	Cross-sectional observational	To systematically investigate language in toddlers with ASD and to identify early correlates of receptive and expressive language in this population
	Miniscalco 2012[391]	Sweden	Cross-sectional observational	To establish whether parents of young children with autism identify the same rate and type of language problems as SLPs using formal tests To describe the typical 'language profile' in a representative sample of toddlers with autism
	Mitchell 2006[392]	Canada	Longitudinal observational	Assessment at 18 and 24 months
	Oosterling 2010[326]	The Netherlands	Intervention RCT	Intervention is 'Focus parent training'. Home-based parent training promoting compliance, mutual enjoyment, joint attention and language development
	Rogers 2012[317]	USA	Intervention RCT	This study was carried out to examine the efficacy of a 12-week, low-intensity (1 hour per week of therapist contact), parent-delivered intervention for toddlers at risk for ASDs aged 14–24 months and their families
	Salt 2002[372]	UK	Intervention quasi-experimental	Developmentally based early intervention programme
	Smith 2007[393]	Canada	Longitudinal observational	Variability and predictors of expressive vocabulary development in children with autism
	Smith 2010[359]	Canada and USA	Intervention quasi-experimental	Effect of a parent training and naturalistic one-to-one behaviour intervention using PRT on language, behaviour and ASD symptoms

Language	Paper	Location	Study design	Study aim
	Stone 2001[394]	USA	Longitudinal observational	Examining factors related to development of spoken language
	Strauss 2012[329]	Italy	Intervention quasi-experimental	Influence of parent inclusion in treatment provision on child's progress
Mullen Scales of Early Learning (MSEL)	Akshoomoff 2006[395]	USA	Cross-sectional observational	Overt behaviours during cognitive assessment
	Anan 2008[396]	USA	Other – quantitative case series	To examine the efficacy of the GIFT programme, a 12-week (180 hours, delivered 3 hours each weekday) parent-training for preschoolers with ASDs
	Baker 2010[397]	USA	Longitudinal observational	'Examined parent behaviour during unstructured play sessions with high- and low-risk toddlers who did or did not receive later ASD diagnoses, and investigated associations with concurrent child behaviour problems and later language growth'
	Barbaro 2012[398]	Australia	Longitudinal observational	To investigate the developmental profiles of children with ASDs from 12 to 24 months, who had been prospectively identified through developmental surveillance in a large community-based sample
	Ben Itzchak 2011[320]	Israel	Intervention quasi-experimental	The study explored child and parental characteristics at baseline that may predict outcomes in adaptive skills and acquisition of cognitive gains
	Bishop 2011[176]	USA	Cross-sectional observational	Validation of MSEL in a population of children with children with ASDs and other developmental disorders
	Brian 2008[305]	Canada	Longitudinal observational	Assessment of potential behavioural markers of ASD at 18 months in a high-risk cohort of infant siblings of children with ASD
	Dawson 2010[321]	USA	Intervention RCT	Efficacy of the ESDM, a comprehensive developmental behavioural intervention, for improving outcomes in ASD toddlers
	Dereu 2012[365]	Belgium	Longitudinal observational	Developmental trajectories of joint attention, imitation and pretend play impairments in autism
	Eapen 2013[357]	Australia	Longitudinal observational	Evaluation of ESDM for preschool-aged children with ASD
	Hartley 2009[323]	USA	Cross-sectional observational	To explore developmental patterns, along gender lines, in children who have autism

Language	Paper	Location	Study design	Study aim
	Honey 2008[307]	UK	Longitudinal observational	The study tests the following specific hypotheses: 1. Repetitive behaviour items from the ADI-R will group into four factors as identified in ICD-10 2. Children with better ability will have fewer repetitive behaviours than those children with lesser ability 3. Children with better ability will demonstrate a different pattern of repetitive behaviours from children with lesser ability 4. Repetitive behaviours will increase over time in children with ASD
	Landa 2012[399]	USA	Longitudinal observational	Developmental trajectories of siblings of ASD children
	Landa 2012[324]	USA	Intervention quasi-experimental	Comprehensive early intervention
	Lloyd 2013[400]	USA	Cross-sectional observational	Gross and fine motor skills of young children with ASD
	Luyster 2008[129]	USA	Cross-sectional observational	To systematically investigate language in toddlers with ASD and to identify early correlates of receptive and expressive language in this population
	Mayo 2013[310]	USA	Other – retrospective observational	This study examined the relationship between age of language acquisition and later functioning in children with ASD
	Mitchell 2006[392]	Canada	Longitudinal observational	Assessment at 18 and 24 months
	O'Donnell 2012[386]	USA	Cross-sectional observational	To explore sensory processing characteristics in preschool-age children with ASDs
	Ozonoff 2010[313]	USA	Longitudinal observational	'To examine prospectively the emergence of behavioural signs of autism in the first years of life in infants at low and high risk for autism'
	Poon 2012[401]	USA	Longitudinal observational	'The current study uses retrospective video analysis (RVA) methods to investigate the longitudinal trajectories of social-communicative behaviours, as well as their associations with later developmental outcomes'
	Ray-Subramanian 2012[328]	USA	Longitudinal observational	This study examined whether language skills and non-verbal cognitive skills were associated with clinician-observed RRBs in children with ASD

Language	Paper	Location	Study design	Study aim
	Rogers 2012[317]	USA	Intervention RCT	This study was carried out to examine the efficacy of a 12-week, low-intensity (1 hour per week of therapist contact), parent-delivered intervention for toddlers at risk for ASDs aged 14–24 months and their families
	Schertz 2013[402]	USA	Intervention RCT	The purpose of this study was to determine effects of the JAML intervention on acquisition of joint attention and other early social communication competencies for toddlers with ASDs
	Siller 2013[403]	USA	Intervention RCT	To investigate the underlying causal mechanisms of language gain, we conducted a randomised clinical trial of an experimental intervention (FPI) that aims to enhance responsive parental communication ($n = 70$)
	Sullivan 2007[330]	USA	Longitudinal observational	To examine whether RJA was impaired as early as 14 months in children later diagnosed with ASD and whether RJA was an early marker for ASD diagnosis at outcome
	Tek 2012[331]	USA	Cross-sectional observational	To assess whether early symptom presentation differs in toddlers with ASD from ethnic minority vs. non-minority backgrounds
	Thurm 2007[404]	USA	Longitudinal observational	Non-verbal ability, receptive communication, expressive communication and socialisation were compared as predictors of receptive and expressive language at age 5 years
	Toth 2006[284]	USA	Longitudinal observational	This study investigated the unique contributions of joint attention, imitation, and toy play to language ability and rate of development of communication skills in young children with ASD
	Ventola 2007[332]	USA	Cross-sectional observational	Behavioural presentation of AD, developmental delay and developmental language disorder
	Werner 2005[316]	USA	Cross-sectional observational	Describing variations in early course of development
	Zachor 2010[335]	Israel	Longitudinal observational	To examine the effect of the intervention approach (ABA, eclectic) on outcome in cognitive, language, and adaptive skills and on changes in autism diagnosis categories

Language	Paper	Location	Study design	Study aim
Pragmatics Profile	Roberts 2011[405]	Australia	Intervention RCT	Comparison of home-based vs. centre-based early intervention programmes
Preschool Language Scale (PLS)	Bopp 2009[340]	Canada	Longitudinal observational	Examined the relationship between behaviour and trajectories of vocabulary and language development in young children with autism
	Casenhiser 2013[361]	Canada	Longitudinal observational	To assess the impact of an intervention on social interaction and communication in children with ASD
	Flippin 2011[406]	USA	Longitudinal observational	To investigate the concurrent relationships between the verbal and play responsiveness of 16 mothers and fathers and the object play skills of 16 children with ASDs
	Green 2010[253]	UK	Intervention RCT	Early interventions for social communication
	Haebig 2013[407]	USA	Longitudinal observational	Parent verbal responsiveness and language comprehension and production
	Harris 1991[408]	USA	Longitudinal observational	To explore developmental (intellectual and language) gains made by children with autism following intervention
	Hudry 2010[233]	UK	Cross-sectional observational	Recruited as part of Preschool Autism Communication Trial but this report is on baseline data for only receptive vs. expressive skills
	Mitchell 2006[392]	Canada	Longitudinal observational	Assessment at 18 and 24 months
	Ray-Subramanian 2012[328]	USA	Longitudinal observational	This study examined whether language skills and non-verbal cognitive skills were associated with clinician-observed RRBs in children with ASD
	Smith 2010[359]	Canada and USA	Intervention quasi-experimental	Effect of a parent training and naturalistic one-to-one behaviour intervention using PRT on language, behaviour and ASD symptoms
	Stone 2001[394]	USA	Longitudinal observational	Examining factors related to development of spoken language
Reynell Developmental Language Scales	Andersson 2013[409]	Sweden	Longitudinal observational	To explore gender-related differences in ASD characteristics
	Bono 2004[389]	USA	Longitudinal observational	Investigate the relationship between amount of intervention and language development in children with autism
	Carlsson 2013[390]	Sweden	Cross-sectional observational	To analyse co-occurring disorders and problems in a representative group of 198 preschool children with ASD

Language	Paper	Location	Study design	Study aim
	Eikeseth 2009[410]	UK	Longitudinal observational	Effect of intensity of supervision on outcomes
	Goods 2013[366]	USA	Intervention RCT	JASPER
	Herring 2006[411]	Australia	Longitudinal observational	To explore the impact of developmental disorders on children and their families
	Miniscalco 2012[391]	Sweden	Cross-sectional observational	To establish whether or not parents of young children with autism identify the same rate and type of language problems as SLPs using formal tests To describe the typical 'language profile' in a representative sample of toddlers with autism
	Remington 2007[358]	UK	Intervention quasi-experimental	Comparison of early intensive behavioural interventions and treatment as usual
	Roberts 2011[405]	Australia	Intervention RCT	Comparison of home-based vs. centre-based early intervention programmes
	Sheinkopf 2000[412]	USA	Cross-sectional observational	Examine both vocal and gestural communicative development in young children with autism
	Smith 2000[413]	USA	Intervention RCT	Comparing intensive treatment group to parent training group
Sequenced Inventory of Communication-Revised	Stone 2001[394]	USA	Longitudinal observational	Examining factors related to development of spoken language
Test for Auditory Comprehension of Language	Szatmari 2000[302]	Canada	Longitudinal observational	Monitoring cognitive and language outcomes of groups of children with autism and Asperger syndrome
Test of Language Development	Bennett 2008[296]	Canada	Longitudinal observational	To explore 'specific language impairment' as a predictor of children's symptom and functional outcome
	Szatmari 2000[302]	Canada	Longitudinal observational	Monitoring cognitive and language outcomes of groups of children with autism and Asperger syndrome
Vineland Adaptive Behavior Scales (VABS)	Aldred 2004[318]	England	Intervention RCT	'Social communication intervention targeting parental communication'
	Anan 2008[396]	USA	Other – quantitative case series	To examine the efficacy of the GIFT programme, a 12-week (180 hours, delivered 3 hours each weekday) parent training for preschoolers with ASDs
	Andersson 2013[409]	Sweden	Longitudinal observational	To explore gender-related differences in ASD characteristics

Language	Paper	Location	Study design	Study aim
	Arick 2003[388]	USA	Cross-sectional observational	To track programme implementation variables and outcome data for students with ASDs engaged in school or home programmes
	Baghdadli 2012[339]	France	Longitudinal observational	Developmental trajectory of adaptive behaviours
	Bearss 2013[278]	USA	Longitudinal observational	To assess the feasibility and efficacy of a parent training programme
	Ben Itzchak 2011[320]	Israel	Intervention quasi-experimental	The study explored child and parental characteristics at baseline that may predict outcomes in adaptive skills and acquisition of cognitive gains
	Bennett 2008[296]	Canada	Longitudinal observational	To explore 'specific language impairment' as a predictor of children's symptom and functional outcome
	Carlsson 2013[390]	Sweden	Cross-sectional observational	To analyse co-occurring disorders and problems in a representative group of 198 preschool children with ASD
	Cassidy 2008[348]	Northern Ireland	Cross-sectional observational	To describe the demographic characteristics of preschoolers and their families; to discover parental perceptions of the child's difficulties; to identify the impact the child has on family life; to outline the supports available to families and those they would like to have
	Dawson 2010[321]	USA	Intervention RCT	Efficacy of the ESDM, a comprehensive developmental behavioural intervention, for improving outcomes in ASD toddlers
	Eapen 2013[357]	Australia	Longitudinal observational	Evaluation of ESDM for preschool-aged children with ASD
	Eikeseth 2009[410]	UK	Longitudinal observational	Effect of intensity of supervision on outcomes
	Eldevik 2012[414]	UK (Wales)	Longitudinal observational	Behavioural intervention outcome for children who had autism
	Eriksson 2013[415]	Sweden	Longitudinal observational	To explore frequency of other medical conditions in autism
	Gabriels 2007[416]	USA	Longitudinal observational	To assess the stability of adaptive functioning in two cognitive ability groups of children with an ASD
	Green 2010[253]	UK	Intervention RCT	Early interventions for social communication
	Grindle 2012[417]	UK (Wales)	Intervention quasi-experimental	ABA classroom: educational intervention in a mainstream school setting

Language	Paper	Location	Study design	Study aim
	Hedvall 2013[418]	Sweden	Cross-sectional observational	Processing speed and adaptive function
	Herring 2006[410]	Australia	Longitudinal observational	To explore the impact of developmental disorders on children and their families
	Honey 2008[307]	UK	Longitudinal observational	The study tests the following specific hypotheses: 1. Repetitive behaviour items from the ADI-R will group into four factors as identified in ICD-10 2. Children with better ability will have fewer repetitive behaviours than those children with lesser ability 3. Children with better ability will demonstrate a different pattern of repetitive behaviours from children with lesser ability 4. Repetitive behaviours will increase over time in children with ASD
	Hudry 2010[233]	UK	Cross-sectional observational	Recruited as part of Preschool Autism Communication Trial but this report is on baseline data for only receptive vs. expressive skills
	Jasmin 2009[384]	Canada	Cross-sectional observational	To determine the impact of sensory–motor DLS on the performance of DLS in preschool children with ASD
	Jonsdottir 2007[341]	Iceland	Longitudinal observational	The purpose of the present study was to describe stability and change of preschool children in Iceland and to contribute to the accumulation of data on outcome in autism
	Klintwall 2012[419]	Sweden	Longitudinal observational	Number and controllability of reinforces as predictors of outcomes for autistic children receiving Early and Intense Behavioural Intervention
	Landa 2012[324]	USA	Intervention quasi-experimental	Comprehensive early intervention
	Lerna 2012[325]	Italy	Intervention RCT	PECS vs. CLT
	Lloyd 2013[400]	USA	Cross-sectional observational	Gross and fine motor skills of young children with ASD
	Luyster 2008[129]	USA	Cross-sectional observational	To systematically investigate language in toddlers with ASD and to identify early correlates of receptive and expressive language in this population
	Magiati 2007[308]	UK	Longitudinal observational	To provide data on long-term outcome for children with ASD who have received intensive, comprehensive interventions in their preschool years

Language	Paper	Location	Study design	Study aim
	Magiati 2011[309]	UK	Longitudinal observational	To provide data on long-term outcome for children with ASD who have received intensive, comprehensive interventions in their preschool years
	Mayo 2013[310]	USA	Other – retrospective observational	This study examined the relationship between age of language acquisition and later functioning in children with ASD
	McConkey 2010[349]	–	Intervention quasi-experimental	Evaluate a home-based intervention for preschool children with a confirmed diagnosis of ASD
	Munson 2006[420]	USA	Longitudinal observational	The relationship between amygdalar volume at age 3–4 years and outcomes at age 6 years
	Munson 2008[312]	USA	Cross-sectional observational	Latent class analysis of IQ in ASD
	O'Donnell 2012[386]	USA	Cross-sectional observational	To explore sensory processing characteristics in preschool-age children with ASDs
	Osborne 2008[350]	UK	Intervention quasi-experimental	There was great heterogeneity among the interventions delivered and so for analysis interventions were categorised into high vs. low intensity
	Osborne 2009[351]	UK	Longitudinal observational	Evaluate relationship between child behaviour problems and parental stress
	Peters-Scheffer 2010[421]	The Netherlands	Intervention quasi-experimental	Behavioural treatment in preschool
	Poon 2012[401]	USA	Longitudinal observational	'The current study uses retrospective video analysis (RVA) methods to investigate the longitudinal trajectories of social-communicative behaviours, as well as their associations with later developmental outcomes'
	Pry 2005[314]	France, Switzerland, Belgium and Luxembourg	Cross-sectional observational	The relationship between expressive language level and psychological development in children with autism 5 years of age
	Ray-Subramanian 2011[327]	USA	Cross-sectional observational	'Their study examined adaptive behaviour and cognitive skills for 125 toddlers on the autism spectrum using the recently updated Vineland-II and Bayley-III'
	Reed 2007[352]	UK	Longitudinal observational	Comparing high- and low-intensity interventions (with comparison of three different types of high-intensity interventions)

Language	Paper	Location	Study design	Study aim
	Reed 2007[353]	UK	Longitudinal observational	Compare effectiveness of ABA, special nursery placements and portage; addressing limitations of previous studies by using the same measures at baseline and end point
	Reed 2012[354]	UK	Intervention quasi-experimental	To explore and document the relationships between severity of autism, temporal input of the programme, and the outcome effectiveness for a variety of early interventions for children on the autism spectrum. In particular, ABA, special nursery placement, an adaptation of a portage approach for individuals on the autism spectrum, and an eclectic approach developed by a local authority were chosen for study
	Remington 2007[358]	UK	Intervention quasi-experimental	Comparison of early intensive behavioural interventions and treatment as usual
	Restall 1994[422]	Canada	Cross-sectional observational	How does the play of children with autism differ that of normally developing children? What are the relationships between performance and adaptive abilities?
	Rickards 2009[423]	Australia	Intervention RCT	Does home-based programme provided over 12 months result in sustained improvement in development and behaviour?
	Roberts 2011[405]	Australia	Intervention RCT	Comparison of home-based vs. centre-based early intervention programmes
	Rogers 2012[317]	USA	Intervention RCT	This study was carried out to examine the efficacy of a 12-week, low-intensity (1 hour per week of therapist contact), parent-delivered intervention for toddlers at risk for ASDs aged 14–24 months and their families
	Ruble 2008[424]	USA	Cross-sectional observational	Effect of caregiver responsiveness on child cognitive and social interactions
	Salt 2002[372]	UK	Intervention quasi-experimental	Developmentally based early intervention programme
	Schertz 2013[402]	USA	Intervention RCT	The purpose of this study was to determine effects of the JAML intervention on acquisition of joint attention and other early social communication competencies for toddlers with ASDs
	Silva 2007[299]	USA	Intervention RCT	Effectiveness of qigong massage methodology, in treating sensory impairment in young children with autism

Language	Paper	Location	Study design	Study aim
	Silva 2008[300]	USA	Intervention RCT	Outcomes of pilot of qigong sensory training programme
	Smith 2000[413]	USA	Intervention RCT	Comparing intensive treatment group to parent training group
	Smith 2010[359]	Canada and USA	Intervention quasi-experimental	Effect of a parent training and naturalistic one-to-one behaviour intervention using PRT on language, behaviour and ASD symptoms
	Stahmer 2004[355]	USA	Intervention quasi-experimental	To analyse the outcomes for 20 young children with ASD in an inclusive programme for children aged < 3 years
	Stone 1999[346]	USA	Cross-sectional observational	Patterns of adaptive behaviour in young children with ASD
	Strauss 2012[329]	Italy	Intervention quasi-experimental	Influence of parent inclusion in treatment provision on child's progress
	Szatmari 2000[302]	Canada	Longitudinal observational	Monitoring cognitive and language outcomes of groups of children with autism and Asperger syndrome
	Tonge 2012[425]	Australia	Longitudinal observational	To determine the impact of a PEBM on the mental health and adjustment of parents with preschool children with autism
	Toth 2006[284]	USA	Longitudinal observational	This study investigated the unique contributions of joint attention, imitation and toy play to language ability and rate of development of communication skills in young children with ASD
	VanMeter 1997[426]	USA	Cross-sectional observational	Social, communication and DLS was examined for autistic children, compared with retarded and normal controls
	Ventola 2007[332]	USA	Cross-sectional observational	Behavioural presentation of AD, developmental delay and developmental language disorder
	Werner 2005[316]	USA	Cross-sectional observational	Describing variations in early course of development
	Zachor 2010[335]	Israel	Longitudinal observational	To examine the effect of the intervention approach (ABA, eclectic) on outcome in cognitive, language, and adaptive skills and on changes in autism diagnosis categories
Vineland Adaptive Behavior Scales-Classroom Edition (VABS-Classroom)	Goin-Kochel 2007[427]	USA	Longitudinal observational	To assess the developmental trajectories of children with autism enrolled in ABA-based school

Language	Paper	Location	Study design	Study aim
Differential Ability Scales[a]	Bishop 2011[176]	USA	Cross-sectional observational	Validation of MSEL in a population of children with children with ASDs and other developmental disorders
	Ruble 2008[424]	USA	Cross-sectional observational	Effect of caregiver responsiveness on child cognitive and social interactions
	Thurm 2007[404]	USA	Longitudinal observational	Non-verbal ability, receptive communication, expressive communication and socialisation were compared as predictors of receptive and expressive language at age 5 years
Peabody Picture Vocabulary Test[a]	Bopp 2009[340]	Canada	Longitudinal observational	Examined the relationship between behaviour and trajectories of vocabulary and language development in young children with autism
	Smith 2010[359]	Canada and USA	Intervention quasi-experimental	Effect of a parent training and naturalistic one-to-one behaviour intervention using PRT on language, behaviour and ASD symptoms
	Szatmari 2000[302]	Canada	Longitudinal observational	Monitoring cognitive and language outcomes of groups of children with autism and Asperger syndrome
Processability test[b]	Carlsson 2013[390]	Sweden	Cross-sectional observational	To analyse co-occurring disorders and problems in a representative group of 198 preschool children with ASD
Rating of video for expressive speech[c]	Baghdadli 2012[339]	France	Longitudinal observational	Developmental trajectory of adaptive behaviours
Semi structured free-play with examiner[c]	Yoder 2006[428]	USA	Intervention RCT	Prelinguistic communication intervention for acquisition of spoken communication
Video coding procedures[c]	Colgan 2006[379]	USA	Longitudinal observational	To examine the frequency, initiation, prompting, and diversity of types of gestures used for social interaction purposes

ABA, applied behavioural analysis; AD, autistic disorder; CLT, Conventional Language Therapy; DLS, daily living skills; ESDM, Early Start Denver Model; FPI, Focused Playtime Intervention; GIFT, Group Intensive Family Training; JAML, Joint Attention Mediated Learning; JASPER, Joint Attention Symbolic Play Engagement and Regulation; PEBM, parent education and behaviour management intervention; PECS, Picture Exchange Communication System; PRT, Pivotal Response Treatment; RCT, randomised controlled trial; RJA, response to joint attention; SLP, speech-and-language pathologist.
a Non-UK.
b Tools developed ad hoc.
c Observational coding.

Cognitive ability	Paper	Location	Study design	Study aim
Battelle Developmental Inventory (BDI)	Arick 2003[388]	USA	Cross-sectional observational	To track programme implementation variables and outcome data for students with ASDs engaged in school or home programmes
Bayley Scales of Infant Development (BSID)	Ben Itzchak 2008[149]	Israel	Longitudinal observational	To examine the relations between cognition and autism severity, head size and intervention outcome
	Eikeseth 2009[410]	UK	Longitudinal observational	Effect of intensity of supervision on outcomes
	Eldevik 2012[414]	UK (Wales)	Longitudinal observational	Behavioural intervention outcome for children who had autism
	Grindle 2012[417]	UK (Wales)	Intervention quasi-experimental	ABA classroom: educational intervention in a mainstream school setting
	Ingersoll 2012[286]	USA	Intervention RCT	Imitation intervention to improve social functioning
	Jonsdottir 2007[341]	Iceland	Longitudinal observational	The purpose of the present study was to describe stability and change of preschool children in Iceland and to contribute to the accumulation of data on outcome in autism
	Magiati 2007[308]	UK	Longitudinal observational	To provide data on long-term outcome for children with ASD who have received intensive, comprehensive interventions in their preschool years
	Peters-Scheffer 2010[421]	The Netherlands	Intervention quasi-experimental	Behavioural treatment in preschool
	Ray-Subramanian 2011[327]	USA	Cross-sectional observational	'Their study examined adaptive behaviour and cognitive skills for 125 toddlers on the autism spectrum using the recently updated Vineland-II and Bayley-III'
	Remington 2007[358]	UK	Intervention quasi-experimental	Comparison of early intensive behavioural interventions and treatment as usual
	Rickards 2009[423]	Australia	Intervention RCT	Does home-based programme provided over 12 months resulted in sustained improvement in development and behaviour?
	Sheinkopf 1998[429]	USA	Intervention quasi-experimental	Examine the effects of intensive behaviour therapy on the intellectual functioning and symptom presentation of young children diagnosed with autism or PDD
	Smith 1997[430]	Norway and USA	Intervention quasi-experimental	Outcomes after 'intensive behavioural treatment'
	Smith 2000[413]	USA	Intervention RCT	Comparing intensive treatment group to parent training group

Cognitive ability	Paper	Location	Study design	Study aim
	Stahmer 2004[355]	USA	Intervention quasi-experimental	To analyse the outcomes for 20 young children with ASD in an inclusive programme for children aged < 3 years
	Ventola 2007[332]	USA	Cross-sectional observational	Behavioural presentation of AD, developmental delay and developmental language disorder
	Zachor 2006[334]	Israel	Intervention quasi-experimental	To compare the outcome of two centre-based intervention for autism
Behavior Rating Inventory of Executive Function (BRIEF)–Preschool Version	Jahromi 2013[431]	USA	Longitudinal observational	The importance of self-regulation for the school and peer engagement of children with high-functioning autism
British Ability Scales (BAS)	Osborne 2008[350]	UK	Intervention quasi-experimental	There was great heterogeneity among the interventions delivered and so for analysis interventions were categorised into high vs. low intensity
	Osborne 2009[351]	UK	Longitudinal observational	Evaluate relationship between child behaviour problems and parental stress
	Reed 2007[352]	UK	Longitudinal observational	Comparing high- and low-intensity interventions (with comparison of three different types of high-intensity interventions)
	Reed 2007[353]	UK	Longitudinal observational	Compare effectiveness of ABA, special nursery placements and portage; addressing limitations of previous studies by using the same measures at baseline and end point
	Reed 2012[354]	UK	Intervention quasi-experimental	To explore and document the relationships between severity of autism, temporal input of the programme, and the outcome effectiveness for a variety of early interventions for children on the autism spectrum. In particular, ABA, special nursery placement, an adaptation of a portage approach for individuals on the autism spectrum, and an eclectic approach developed by a local authority were chosen for study
Cattell Infant Intelligence	Sheinkopf 1998[429]	USA	Intervention quasi-experimental	Examine the effects of intensive behaviour therapy on the intellectual functioning and symptom presentation of young children diagnosed with autism or PDD
Developmental Profile	Malhi 2011[342]	India	Longitudinal observational	To assess diagnostic stability of autism diagnosis in children aged ≤ 3 years

Cognitive ability	Paper	Location	Study design	Study aim
Griffith Mental Developmental Scales	Andersson 2013[409]	Sweden	Longitudinal observational	To explore gender-related differences in ASD characteristics
	Carlsson 2013[390]	Sweden	Cross-sectional observational	To analyse co-occurring disorders and problems in a representative group of 198 preschool children with ASD
	Hedvall 2013[418]	Sweden	Cross-sectional observational	Processing speed and adaptive function
	Lerna 2012[325]	Italy	Intervention RCT	PECS vs. CLT
	Strauss 2012[329]	Italy	Intervention quasi-experimental	Influence of parent inclusion in treatment provision on child's progress
Leiter International Performance Scale-Revised (Leiter-R)	Gabriels 2007[416]	USA	Longitudinal observational	To assess the stability of adaptive functioning in two cognitive ability groups of children with an ASD
	Grindle 2012[417]	UK (Wales)	Intervention quasi-experimental	ABA classroom: educational intervention in a mainstream school setting
Leiter Performance Scales (Arthur adaptation)	Bennett 2008[296]	Canada	Longitudinal observational	To explore 'specific language impairment' as a predictor of children's symptom and functional outcome
McCarthy Scales of Children's Abilities	Szatmari 2000[302]	Canada	Longitudinal observational	Monitoring cognitive and language outcomes of groups of children with autism and Asperger syndrome
Merrill–Palmer Scale of Mental Tests	Eikeseth 2009[410]	UK	Longitudinal observational	Effect of intensity of supervision on outcomes
	Magiati 2007[308]	UK	Longitudinal observational	To provide data on long-term outcome for children with ASD who have received intensive, comprehensive interventions in their preschool years
	Sheinkopf 1998[429]	USA	Intervention quasi-experimental	Examine the effects of intensive behaviour therapy on the intellectual functioning and symptom presentation of young children diagnosed with autism or PDD
	Sheinkopf 2000[412]	USA	Cross-sectional observational	Examine both vocal and gestural communicative development in young children with autism
	Smith 2000[413]	USA	Intervention RCT	Comparing intensive treatment group to parent training group
Merrill-Palmer-Revised	Smith 2010[359]	Canada and USA	Intervention quasi-experimental	Effect of a parent training and naturalistic one-to-one behaviour intervention using PRT on language, behaviour and ASD symptoms

Cognitive ability	Paper	Location	Study design	Study aim
Mullen Scales of Early Learning (MSEL)	Akshoomoff 2006[395]	USA	Cross-sectional observational	Overt behaviours during cognitive assessment
	Anan 2008[396]	USA	Other – quantitative case series	To examine the efficacy of the GIFT programme, a 12-week (180 hours, delivered 3 hours each weekday) parent-training for preschoolers with ASDs
	Baker 2010[397]	USA	Longitudinal observational	'Examined parent behaviour during unstructured play sessions with high- and low-risk toddlers who did or did not receive later ASD diagnoses, and investigated associations with concurrent child behaviour problems and later language growth'
	Barbaro 2012[398]	Australia	Longitudinal observational	To investigate the developmental profiles of children with ASDs from 12 to 24 months, who had been prospectively identified through developmental surveillance in a large community-based sample
	Ben Itzchak 2011[320]	Israel	Intervention quasi-experimental	The study explored child and parental characteristics at baseline that may predict outcomes in adaptive skills and acquisition of cognitive gains
	Bishop 2011[176]	USA	Cross-sectional observational	Validation of MSEL in a population of children with children with ASDs and other developmental disorders
	Brian 2008[305]	Canada	Longitudinal observational	Assessment of potential behavioural markers of ASD at 18 months in a high-risk cohort of infant siblings of children with ASD
	Dawson 2010[321]	USA	Intervention RCT	Efficacy of the ESDM, a comprehensive developmental behavioural intervention, for improving outcomes in ASD toddlers
	Dereu 2012[365]	Belgium	Longitudinal observational	Developmental trajectories of joint attention, imitation and pretend play impairments in autism
	Eapen 2013[357]	Australia	Longitudinal observational	Evaluation of ESDM for preschool-aged children with ASD
	Hartley 2009[323]	USA	Cross-sectional observational	To explore developmental patterns, along gender lines, in children who have autism
	Honey 2008[307]	UK	Longitudinal observational	The study tests the following specific hypotheses: 1. Repetitive behaviour items from the ADI-R will group into four factors as identified in ICD-10 2. Children with better ability will have fewer repetitive behaviours than those children with lesser ability

Cognitive ability	Paper	Location	Study design	Study aim
				3. Children with better ability will demonstrate a different pattern of repetitive behaviours from children with lesser ability 4. Repetitive behaviours will increase over time in children with ASD
	Landa 2012[399]	USA	Longitudinal observational	Developmental trajectories of siblings of ASD children
	Landa 2012[224]	USA	Intervention quasi-experimental	Comprehensive early intervention
	Lloyd 2013[400]	USA	Cross-sectional observational	Gross and fine motor skills of young children with ASD
	Luyster 2008[129]	USA	Cross-sectional observational	To systematically investigate language in toddlers with ASD and to identify early correlates of receptive and expressive language in this population
	Mayo 2013[310]	USA	Other – retrospective observational	This study examined the relationship between age of language acquisition and later functioning in children with ASD
	Mitchell 2006[392]	Canada	Longitudinal observational	Assessment at 18 and 24 months
	O'Donnell 2012[386]	USA	Cross-sectional observational	To explore sensory processing characteristics in preschool-age children with ASDs
	Ozonoff 2010[313]	USA	Longitudinal observational	'To examine prospectively the emergence of behavioural signs of autism in the first years of life in infants at low and high risk for autism'
	Poon 2012[401]	USA	Longitudinal observational	'The current study uses retrospective video analysis (RVA) methods to investigate the longitudinal trajectories of social-communicative behaviours, as well as their associations with later developmental outcomes'
	Ray-Subramanian 2012[328]	USA	Longitudinal observational	This study examined whether language skills and non-verbal cognitive skills were associated with clinician-observed RRBs in children with ASD
	Rogers 2012[317]	USA	Intervention RCT	This study was carried out to examine the efficacy of a 12-week, low-intensity (1 hour per week of therapist contact), parent-delivered intervention for toddlers at risk for ASDs aged 14–24 months and their families
	Schertz 2013[402]	USA	Intervention RCT	The purpose of this study was to determine effects of the JAML intervention on acquisition of joint attention and other early social communication competencies for toddlers with ASDs

Cognitive ability	Paper	Location	Study design	Study aim
	Siller 2013[403]	USA	Intervention RCT	To investigate the underlying causal mechanisms of language gain, we conducted a randomised clinical trial of an experimental intervention (FPI) that aims to enhance responsive parental communication ($n = 70$)
	Sullivan 2007[330]	USA	Longitudinal observational	To examine whether RJA was impaired as early as 14 months in children later diagnosed with ASD and whether RJA was an early marker for ASD diagnosis at outcome
	Tek 2012[331]	USA	Cross-sectional observational	To assess whether early symptom presentation differs in toddlers with ASD from ethnic minority vs. non-minority backgrounds
	Thurm 2007[404]	USA	Longitudinal observational	Non-verbal ability, receptive communication, expressive communication and socialisation were compared as predictors of receptive and expressive language at age 5 years
	Toth 2006[284]	USA	Longitudinal observational	This study investigated the unique contributions of joint attention, imitation, and toy play to language ability and rate of development of communication skills in young children with ASD
	Ventola 2007[332]	USA	Cross-sectional observational	Behavioural presentation of AD, developmental delay and developmental language disorder
	Werner 2005[316]	USA	Cross-sectional observational	Describing variations in early course of development
	Zachor 2010[335]	Israel	Longitudinal observational	To examine the effect of the intervention approach (ABA, eclectic) on outcome in cognitive, language, and adaptive skills and on changes in autism diagnosis categories
Snijders Oomen Non-Verbal Intelligence Test (SON)	Peters-Scheffer 2010[421]	The Netherlands	Intervention quasi-experimental	Behavioural treatment in preschool
Stanford–Binet Intelligence Scales	Ben Itzchak 2008[149]	Israel	Longitudinal observational	To examine the relations between cognition and autism severity, head size and intervention outcome
	Delmolino 2006[432]	USA	Longitudinal observational	To assess if scores obtained by the PEP-R are reasonable estimates of cognitive ability, correlating with scores from another instrument (Stanford–Binet Intelligence Scales, 4th edn)
	Grindle 2012[417]	UK (Wales)	Intervention quasi-experimental	ABA classroom: educational intervention in a mainstream school setting

Cognitive ability	Paper	Location	Study design	Study aim
	Harris 1991[408]	USA	Longitudinal observational	To explore developmental (intellectual and language) gains made by children with autism following intervention
	Harris 2000[433]	USA	Cross-sectional observational	To explore the impact of age and baseline IQ (moderators) on outcome following intervention
	Landa 2012[224]	USA	Intervention quasi-experimental	Comprehensive early intervention
	Remington 2007[358]	UK	Intervention quasi-experimental	Comparison of early intensive behavioural interventions and treatment as usual
	Smith 2000[413]	USA	Intervention RCT	Comparing intensive treatment group to parent training group
	Szatmari 2000[302]	Canada	Longitudinal observational	Monitoring cognitive and language outcomes of groups of children with autism and Asperger syndrome
	Zachor 2006[334]	Israel	Intervention quasi-experimental	To compare the outcome of two centre-based intervention for autism
Wechsler Intelligence Scale for Children	Szatmari 2000[302]	Canada	Longitudinal observational	Monitoring cognitive and language outcomes of groups of children with autism and Asperger syndrome
Wechsler Preschool and Primary Scale of Intelligence (WPPSI)	Andersson 2013[409]	Sweden	Longitudinal observational	To explore gender-related differences in ASD characteristics
	Baghdadli 2012[339]	France	Longitudinal observational	Developmental trajectory of adaptive behaviours
	Carlsson 2013[390]	Sweden	Cross-sectional observational	To analyse co-occurring disorders and problems in a representative group of 198 preschool children with ASD
	Eikeseth 2009[410]	UK	Longitudinal observational	Effect of intensity of supervision on outcomes
	Hedvall 2013[418]	Sweden	Cross-sectional observational	Processing speed and adaptive function
	Jonsdottir 2007[341]	Iceland	Longitudinal observational	The purpose of the present study was to describe stability and change of preschool children in Iceland and to contribute to the accumulation of data on outcome in autism
	Magiati 2007[308]	UK	Longitudinal observational	To provide data on long-term outcome for children with ASD who have received intensive, comprehensive interventions in their preschool years
	Rickards 2009[423]	Australia	Intervention RCT	Does home-based programme provided over 12 months resulted in sustained improvement in development and behaviour?

Cognitive ability	Paper	Location	Study design	Study aim
	Sheinkopf 1998[429]	USA	Intervention quasi-experimental	To examine the effects of intensive behaviour therapy on the intellectual functioning and symptom presentation of young children diagnosed with autism or PDD
Differential Ability Scales[a]	Bishop 2011[176]	USA	Cross-sectional observational	Validation of MSEL in a population of children with children with ASDs and other developmental disorders
	Ruble 2008[424]	USA	Cross-sectional observational	Effect of caregiver responsiveness on child cognitive and social interactions
	Thurm 2007[404]	USA	Longitudinal observational	Non-verbal ability, receptive communication, expressive communication and socialisation were compared as predictors of receptive and expressive language at age 5 years
Kyoto Scale of Psychological Development[a]	Takeda 2005[360]	Japan	Longitudinal observational	Clinical variables at age 2 years predictive of mental retardation at age 5 years in children with PDD
Tanaka–Binet Intelligence Test (Japanese version of Stanford–Binet)[a]	Takeda 2005[360]	Japan	Longitudinal observational	Clinical variables at age 2 years predictive of mental retardation at age 5 years in children with PDD
Snabbt Performance Test På Intelligence IQ II (SPIQ) – Swedish[a]	Carlsson 2013[390]	Sweden	Cross-sectional observational	To analyse co-occurring disorders and problems in a representative group of 198 preschool children with ASD

ABA, applied behavioural analysis; AD, autistic disorder; CLT, Conventional Language Therapy; FPI, Focused Playtime Intervention; GIFT, Group Intensive Family Training; JAML, Joint Attention Mediated Learning; PECS, Picture Exchange Communication System; PRT, Pivotal Response Treatment; RCT, randomised controlled trial; RJA, response to joint attention.
a Non-UK.

Attention	Paper	Location	Study design	Study aim
Behavior Assessment System for Children-Second Edition (BASC-2)	Hill-Chapman 2013[434]	USA	Cross-sectional observational	Parenting stress
Child Behavior Scale (CBS)	Jahromi 2013[431]	USA	Longitudinal observational	The importance of self-regulation for the school and peer engagement of children with high-functioning autism
	Meek 2012[435]	USA	Cross-sectional observational	To examine group differences in discrete dimensions of social competence between high-functioning autism children and their typically developing peers
Child Behavior Checklist (CBCL)	Baker 2010[397]	USA	Longitudinal observational	'Examined parent behaviour during unstructured play sessions with high- and low-risk toddlers who did or did not receive later ASD diagnoses, and investigated associations with concurrent child behaviour problems and later language growth'
	Hartley 2009[323]	USA	Cross-sectional observational	To explore developmental patterns, along gender lines, in children who have autism
	Peters-Scheffer 2010[421]	The Netherlands	Intervention quasi-experimental	Behavioural treatment in preschool
	Smith 2000[413]	USA	Intervention RCT	Comparing intensive treatment group to parent training group
	Smith 2010[359]	Canada and USA	Intervention quasi-experimental	Effect of a parent training and naturalistic one-to-one behaviour intervention using PRT on language, behaviour and ASD symptoms
	Taylor 2012[436]	USA	Longitudinal observational	To examine the reported symptoms and correlates of depression in caregivers of young children following ASD diagnosis
Child Behaviour Questionnaire-Short Form	Jahromi 2013[431]	USA	Longitudinal observational	The importance of self-regulation for the school and peer engagement of children with high-functioning autism
Conners Rating Scales-Revised	Escalona 2001[271]	USA	Intervention RCT	To explore the effectiveness of massage therapy on stereotypic behaviour among children diagnosed with autism
	Osborne 2009[351]	UK	Longitudinal observational	Evaluate relationship between child behaviour problems and parental stress
	Reed 2007[353]	UK	Longitudinal observational	Compare effectiveness of ABA, special nursery placements and portage; addressing limitations of previous studies by using the same measures at baseline and end point
	Reed 2013[437]	UK	Cross-sectional observational	The study assessed whether teacher and parent ratings of child behaviour problems were similar for children with ASDs
Student attention – coded observation[a]	Travers 2011[438]	USA	Cross-sectional observational	Comparing teacher- and computer-led instruction on literacy skills development

ABA, applied behavioural analysis; PRT, Pivotal Response Treatment; RCT, randomised controlled trial.
a Observational coding.

Emotion regulation	Paper	Location	Study design	Study aim
Baby and Infant Screen for Children with aUtIsm Traits (BISCUIT-Part 2)	Davis 2010[439]	USA	Longitudinal observational	To explore the symptoms of anxiety in very young children with ASDs
Behavior Assessment System for Children-Second Edition (BASC-2)	Hill-Chapman 2013[434]	USA	Cross-sectional observational	Parenting stress
Child Behavior Checklist (CBCL)	Baker 2010[397]	USA	Longitudinal observational	'Examined parent behaviour during unstructured play sessions with high- and low-risk toddlers who did or did not receive later ASD diagnoses, and investigated associations with concurrent child behaviour problems and later language growth'
	Hartley 2009[323]	USA	Cross-sectional observational	To explore developmental patterns, along gender lines, in children who have autism
	Peters-Scheffer 2010[421]	The Netherlands	Intervention quasi-experimental	Behavioural treatment in preschool
	Smith 2000[413]	USA	Intervention RCT	Comparing intensive treatment group to parent training group
	Smith 2010[359]	Canada and USA	Intervention quasi-experimental	Effect of a parent training and naturalistic one-to-one behaviour intervention using PRT on language, behaviour and ASD symptoms
	Taylor 2012[436]	USA	Longitudinal observational	To examine the reported symptoms and correlates of depression in caregivers of young children following ASD diagnosis
Children's Global Assessment Scale (CGAS)	Andersson 2013[409]	Sweden	Longitudinal observational	To explore gender-related differences in ASD characteristics
Conners Rating Scales-Revised	Escalona 2001[271]	USA	Intervention RCT	To explore the effectiveness of massage therapy on stereotypic behaviour among children diagnosed with autism
	Osborne 2009[351]	UK	Longitudinal observational	To evaluate relationship between child behaviour problems and parental stress
	Reed 2007[353]	UK	Longitudinal observational	Compare effectiveness of ABA, special nursery placements and portage; addressing limitations of previous studies by using the same measures at baseline and end point
	Reed 2013[437]	UK	Cross-sectional observational	The study assessed whether teacher and parent ratings of child behaviour problems were similar for children with ASDs

Emotion regulation	Paper	Location	Study design	Study aim
Developmental Behaviour Checklist	Herring 2006[411]	Australia	Longitudinal observational	To explore the impact of developmental disorders on children and their families
	Mooney 2006[311]	Australia	Cross-sectional observational	Examined whether repetitive behaviours are a feature of autism in children aged < 51 months, independent of chronological or developmental age
	Remington 2007[358]	UK	Intervention quasi-experimental	Comparison of early intensive behavioural interventions and treatment as usual
	Roberts 2011[405]	Australia	Intervention RCT	Comparison of home-based vs. centre-based early intervention programmes
	Tonge 2012[425]	Australia	Longitudinal observational	To determine the impact of a PEBM on the mental health and adjustment of parents with preschool children with autism
Emotion Regulation Checklist	Jahromi 2013[431]	USA	Longitudinal observational	The importance of self-regulation for the school and peer engagement of children with high-functioning autism
Infant–Toddler Social–Emotional Assessment (ITSEA)	Ben-Sasson 2008[382]	Unclear	Cross-sectional observational	1. What are the patterns of sensory modulation dimensions of sensory clusters of toddlers with ASDs? 2. Is there a sensory-based subgroup that has higher levels of affective symptoms?

ABA, applied behavioural analysis; PEBM, parent education and behaviour management intervention; PRT, Pivotal Response Treatment; RCT, randomised controlled trial.

Physical skills	Paper	Location	Study design	Study aim
Annett's Pegs	Szatmari 2000[302]	Canada	Longitudinal observational	Monitoring cognitive and language outcomes of groups of children with autism and Asperger syndrome
Beery Visual–Motor Integration Test	Szatmari 2000[302]	Canada	Longitudinal observational	Monitoring cognitive and language outcomes of groups of children with autism and Asperger syndrome
Brunet–Lezine's Oculomotor Coordination Subtest	Baghdadli 2012[339]	France	Longitudinal observational	Developmental trajectory of adaptive behaviours
Functional Independence Measure for children (WeeFIM)	Jasmin 2009[384]	Canada	Cross-sectional observational	To determine the impact of sensory–motor DLS on the performance of DLS in preschool children with ASD
Infant Motor Maturity and Atypicality Coding Scales	Ozonoff 2008[440]	USA	Cross-sectional observational	Assessing gross motor skills in autism; abnormalities relative to developmentally matched children (DD) and TD controls
Mullen Scales of Early Learning (MSEL)	Akshoomoff 2006[395]	USA	Cross-sectional observational	Overt behaviours during cognitive assessment
	Anan 2008[396]	USA	Other – quantitative case series	To examine the efficacy of the GIFT programme, a 12-week (180 hours, delivered 3 hours each weekday) parent-training for preschoolers with ASDs
	Baker 2010[397]	USA	Longitudinal observational	'Examined parent behaviour during unstructured play sessions with high- and low-risk toddlers who did or did not receive later ASD diagnoses, and investigated associations with concurrent child behaviour problems and later language growth'
	Barbaro 2012[398]	Australia	Longitudinal observational	To investigate the developmental profiles of children with ASDs from 12 to 24 months, who had been prospectively identified through developmental surveillance in a large community-based sample
	Ben Itzchak 2011[320]	Israel	Intervention quasi-experimental	The study explored child and parental characteristics at baseline that may predict outcomes in adaptive skills and acquisition of cognitive gains
	Bishop 2011[176]	USA	Cross-sectional observational	Validation of MSEL in a population of children with children with ASDs and other developmental disorders
	Brian 2008[305]	Canada	Longitudinal observational	Assessment of potential behavioural markers of ASD at 18 months in a high-risk cohort of infant siblings of children with ASD

Physical skills	Paper	Location	Study design	Study aim
	Dawson 2010[321]	USA	Intervention RCT	Efficacy of the ESDM, a comprehensive developmental behavioural intervention, for improving outcomes in ASD toddlers
	Dereu 2012[365]	Belgium	Longitudinal observational	Developmental trajectories of joint attention, imitation and pretend play impairments in autism
	Eapen 2013[357]	Australia	Longitudinal observational	Evaluation of ESDM for preschool-aged children with ASD
	Hartley 2009[323]	USA	Cross-sectional observational	To explore developmental patterns, along gender lines, in children who have autism
	Honey 2008[307]	UK	Longitudinal observational	The study tests the following specific hypotheses: 1. Repetitive behaviour items from the ADI-R will group into four factors as identified in ICD-10 2. Children with better ability will have fewer repetitive behaviours than those children with lesser ability 3. Children with better ability will demonstrate a different pattern of repetitive behaviours from children with lesser ability 4. Repetitive behaviours will increase over time in children with ASD
	Landa 2012[399]	USA	Longitudinal observational	Developmental trajectories of siblings of ASD children
	Landa 2012[224]	USA	Intervention quasi-experimental	Comprehensive early intervention
	Lloyd 2013[400]	USA	Cross-sectional observational	Gross and fine motor skills of young children with ASD
	Luyster 2008[129]	USA	Cross-sectional observational	To systematically investigate language in toddlers with ASD and to identify early correlates of receptive and expressive language in this population
	Mayo 2013[310]	USA	Other – retrospective observational	This study examined the relationship between age of language acquisition and later functioning in children with ASD
	Mitchell 2006[392]	Canada	Longitudinal observational	Assessment at 18 and 24 months
	O'Donnell 2012[386]	USA	Cross-sectional observational	To explore sensory processing characteristics in preschool-age children with ASDs
	Ozonoff 2010[313]	USA	Longitudinal observational	'To examine prospectively the emergence of behavioural signs of autism in the first years of life in infants at low and high risk for autism'

Physical skills	Paper	Location	Study design	Study aim
	Poon 2012[401]	USA	Longitudinal observational	'The current study uses retrospective video analysis (RVA) methods to investigate the longitudinal trajectories of social-communicative behaviours, as well as their associations with later developmental outcomes'
	Ray-Subramanian 2012[328]	USA	Longitudinal observational	This study examined whether language skills and non-verbal cognitive skills were associated with clinician-observed RRBs in children with ASD
	Rogers 2012[317]	USA	Intervention RCT	This study was carried out to examine the efficacy of a 12-week, low-intensity (1 hour/week of therapist contact), parent-delivered intervention for toddlers at risk for ASDs aged 14–24 months and their families
	Schertz 2013[402]	USA	Intervention RCT	The purpose of this study was to determine effects of the JAML intervention on acquisition of joint attention and other early social communication competencies for toddlers with ASDs
	Siller 2013[403]	USA	Intervention RCT	To investigate the underlying causal mechanisms of language gain, we conducted a randomised clinical trial of an experimental intervention (FPI) that aims to enhance responsive parental communication ($n = 70$)
	Sullivan 2007[330]	USA	Longitudinal observational	To examine whether RJA was impaired as early as 14 months in children later diagnosed with ASD and whether RJA was an early marker for ASD diagnosis at outcome
	Tek 2012[331]	USA	Cross-sectional observational	To assess whether early symptom presentation differs in toddlers with ASD from ethnic minority vs. non-minority backgrounds
	Thurm 2007[404]	USA	Longitudinal observational	Non-verbal ability, receptive communication, expressive communication and socialisation were compared as predictors of receptive and expressive language at age 5 years
	Toth 2006[284]	USA	Longitudinal observational	This study investigated the unique contributions of joint attention, imitation, and toy play to language ability and rate of development of communication skills in young children with ASD
	Ventola 2007[332]	USA	Cross-sectional observational	Behavioural presentation of AD, developmental delay and developmental language disorder

Physical skills	Paper	Location	Study design	Study aim
	Werner 2005[316]	USA	Cross-sectional observational	Describing variations in early course of development
	Zachor 2010[335]	Israel	Longitudinal observational	To examine the effect of the intervention approach (ABA, eclectic) on outcome in cognitive, language, and adaptive skills and on changes in autism diagnosis categories
Peabody Developmental Motor Scales	Jasmin 2009[384]	Canada	Cross-sectional observational	To determine the impact of sensory–motor DLS on the performance of DLS in preschool children with ASD
	Provost 2007[441]	USA	Cross-sectional observational	Comparing the profiles of gross and fine motor skills in children with ASD and developmental delay
Vineland Adaptive Behavior Scales-Classroom Edition (VABS-Classroom)	Goin-Kochel 2007[427]	USA	Longitudinal observational	To assess the developmental trajectories of children with autism enrolled in ABA-based school
Vineland Adaptive Behavior Scales (VABS)	Aldred 2004[318]	England	Intervention RCT	'Social communication intervention targeting parental communication'
	Anan 2008[396]	USA	Other – quantitative case series	To examine the efficacy of the GIFT programme, a 12-week (180 hours, delivered 3 hours each weekday) parent-training for preschoolers with ASDs
	Andersson 2013[409]	Sweden	Longitudinal observational	To explore gender-related differences in ASD characteristics
	Arick 2003[388]	USA	Cross-sectional observational	To track programme implementation variables and outcome data for students with ASDs engaged in school or home programmes
	Baghdadli 2012[339]	France	Longitudinal observational	Developmental trajectory of adaptive behaviours
	Bearss 2013[278]	USA	Longitudinal observational	To assess the feasibility and efficacy of a parent training programme
	Ben Itzchak 2011[320]	Israel	Intervention quasi-experimental	The study explored child and parental characteristics at baseline that may predict outcomes in adaptive skills and acquisition of cognitive gains
	Bennett 2008[296]	Canada	Longitudinal observational	To explore 'specific language impairment' as a predictor of children's symptom and functional outcome
	Carlsson 2013[390]	Sweden	Cross-sectional observational	To analyse co-occurring disorders and problems in a representative group of 198 preschool children with ASD

Physical skills	Paper	Location	Study design	Study aim
	Cassidy 2008[348]	Northern Ireland	Cross-sectional observational	To describe the demographic characteristics of preschoolers and their families; to discover parental perceptions of the child's difficulties; to identify the impact the child has on family life; to outline the supports available to families and those they would like to have
	Dawson 2010[321]	USA	Intervention RCT	Efficacy of the ESDM, a comprehensive developmental behavioural intervention, for improving outcomes in ASD toddlers
	Eapen 2013[357]	Australia	Longitudinal observational	Evaluation of ESDM for preschool-aged children with ASD
	Eikeseth 2009[410]	UK	Longitudinal observational	Effect of intensity of supervision on outcomes
	Eldevik 2012[414]	UK (Wales)	Longitudinal observational	Behavioural intervention outcome for children who had autism
	Eriksson 2013[415]	Sweden	Longitudinal observational	To explore frequency of other medical conditions in autism
	Gabriels 2007[416]	USA	Longitudinal observational	To assess the stability of adaptive functioning in two cognitive ability groups of children with an ASD
	Green 2010[253]	UK	Intervention RCT	Early interventions for social communication
	Grindle 2012[417]	UK (Wales)	Intervention quasi-experimental	ABA classroom: educational intervention in a mainstream school setting
	Hedvall 2013[418]	Sweden	Cross-sectional observational	Processing speed and adaptive function
	Herring 2006[411]	Australia	Longitudinal observational	To explore the impact of developmental disorders on children and their families
	Honey 2008[307]	UK	Longitudinal observational	The study tests the following specific hypotheses: 1. Repetitive behaviour items from the ADI-R will group into four factors as identified in ICD-10 2. Children with better ability will have fewer repetitive behaviours than those children with lesser ability 3. Children with better ability will demonstrate a different pattern of repetitive behaviours from children with lesser ability 4. Repetitive behaviours will increase over time in children with ASD

Physical skills	Paper	Location	Study design	Study aim
	Hudry 2010[233]	UK	Cross-sectional observational	Recruited as part of Preschool Autism Communication Trial but this report is on baseline data for only receptive vs. expressive skills
	Jasmin 2009[384]	Canada	Cross-sectional observational	To determine the impact of sensory–motor DLS on the performance of DLS in preschool children with ASD
	Jonsdottir 2007[341]	Iceland	Longitudinal observational	The purpose of the present study was to describe stability and change of preschool children in Iceland and to contribute to the accumulation of data on outcome in autism
	Klintwall 2012[419]	Sweden	Longitudinal observational	Number and controllability of reinforces as predictors of outcomes for autistic children receiving Early and Intense Behavioural Intervention
	Landa 2012[224]	USA	Intervention quasi-experimental	Comprehensive early intervention
	Lerna 2012[325]	Italy	Intervention RCT	PECS vs. CLT
	Lloyd 2012[400]	USA	Cross-sectional observational	Gross and fine motor skills of young children with ASD
	Luyster 2008[129]	USA	Cross-sectional observational	To systematically investigate language in toddlers with ASD and to identify early correlates of receptive and expressive language in this population
	Magiati 2007[308]	UK	Longitudinal observational	To provide data on long-term outcome for children with ASD who have received intensive, comprehensive interventions in their preschool years
	Magiati 2011[309]	UK	Longitudinal observational	To provide data on long-term outcome for children with ASD who have received intensive, comprehensive interventions in their preschool years
	Mayo 2013[310]	USA	Other – retrospective observational	This study examined the relationship between age of language acquisition and later functioning in children with ASD
	McConkey 2010[349]	–	Intervention quasi-experimental	Evaluate a home-based intervention for preschool children with a confirmed diagnosis of ASD
	Munson 2006[420]	USA	Longitudinal observational	The relationship between amygdalar volume at age 3–4 years and outcomes at age 6 years
	Munson 2008[312]	USA	Cross-sectional observational	Latent class analysis of IQ in ASD
	O'Donnell 2012[386]	USA	Cross-sectional observational	To explore sensory processing characteristics in preschool-age children with ASDs

Physical skills	Paper	Location	Study design	Study aim
	Osborne 2008[350]	UK	Intervention quasi-experimental	There was great heterogeneity among the interventions delivered and so for analysis interventions were categorised into high vs. low intensity
	Osborne 2009[351]	UK	Longitudinal observational	Evaluate relationship between child behaviour problems and parental stress
	Peters-Scheffer 2010[421]	The Netherlands	Intervention quasi-experimental	Behavioural treatment in preschool
	Poon 2012[401]	USA	Longitudinal observational	'The current study uses retrospective video analysis (RVA) methods to investigate the longitudinal trajectories of social-communicative behaviours, as well as their associations with later developmental outcomes'
	Pry 2005[314]	France, Switzerland, Belgium and Luxembourg	Cross-sectional observational	The relationship between expressive language level and psychological development in children with autism 5 years of age
	Ray-Subramanian 2011[327]	USA	Cross-sectional observational	'Their study examined adaptive behaviour and cognitive skills for 125 toddlers on the autism spectrum using the recently updated Vineland-II and Bayley-III'
	Reed 2007[352]	UK	Longitudinal observational	Comparing high- and low-intensity interventions (with comparison of three different types of high-intensity interventions)
	Reed 2007[353]	UK	Longitudinal observational	Compare effectiveness of ABA, special nursery placements and portage; addressing limitations of previous studies by using the same measures at baseline and end point
	Reed 2012[354]	UK	Intervention quasi-experimental	To explore and document the relationships between severity of autism, temporal input of the programme, and the outcome effectiveness for a variety of early interventions for children on the autism spectrum. In particular, ABA, special nursery placement, an adaptation of a portage approach for individuals on the autism spectrum, and an eclectic approach developed by a local authority were chosen for study
	Remington 2007[358]	UK	Intervention quasi-experimental	Comparison of early intensive behavioural interventions and treatment as usual
	Restall 1994[422]	Canada	Cross-sectional observational	How does the play of children with autism differ that of normally developing children? What are the relationships between performance and adaptive abilities?

Physical skills	Paper	Location	Study design	Study aim
	Rickards 2009[423]	Australia	Intervention RCT	Does home-based programme provided over 12 months result in sustained improvement in development and behaviour?
	Roberts 2011[405]	Australia	Intervention RCT	Comparison of home-based vs. centre-based early intervention programmes
	Rogers 2012[317]	USA	Intervention RCT	This study was carried out to examine the efficacy of a 12-week, low-intensity (1 hour per week of therapist contact), parent-delivered intervention for toddlers at risk for ASDs aged 14–24 months and their families
	Ruble 2008[424]	USA	Cross-sectional observational	Effect of caregiver responsiveness on child cognitive and social interactions
	Salt 2002[372]	UK	Intervention quasi-experimental	Developmentally based early intervention programme
	Schertz 2013[402]	USA	Intervention RCT	The purpose of this study was to determine effects of the JAML intervention on acquisition of joint attention and other early social communication competencies for toddlers with ASDs
	Silva 2007[299]	USA	Intervention RCT	Effectiveness of qigong massage methodology, in treating sensory impairment in young children with autism
	Silva 2008[300]	USA	Intervention RCT	Outcomes of pilot of qigong sensory training programme
	Smith 2000[413]	USA	Intervention RCT	Comparing intensive treatment group to parent training group
	Smith 2010[359]	Canada and USA	Intervention quasi-experimental	Effect of a parent training and naturalistic one-to-one behaviour intervention using PRT on language, behaviour and ASD symptoms
	Stahmer 2004[355]	USA	Intervention quasi-experimental	To analyse the outcomes for 20 young children with ASD in an inclusive programme for children aged < 3 years
	Stone 1999[346]	USA	Cross-sectional observational	Patterns of adaptive behaviour in young children with ASD
	Strauss 2012[329]	Italy	Intervention quasi-experimental	Influence of parent inclusion in treatment provision on child's progress
	Szatmari 2000[302]	Canada	Longitudinal observational	Monitoring cognitive and language outcomes of groups of children with autism and Asperger syndrome
	Tonge 2012[425]	Australia	Longitudinal observational	To determine the impact of a PEBM on the mental health and adjustment of parents with preschool children with autism

Physical skills	Paper	Location	Study design	Study aim
	Toth 2006[284]	USA	Longitudinal observational	This study investigated the unique contributions of joint attention, imitation, and toy play to language ability and rate of development of communication skills in young children with ASD
	VanMeter 1997[426]	USA	Cross-sectional observational	Social, communication and DLS was examined for autistic children, compared with retarded and normal controls
	Ventola 2007[332]	USA	Cross-sectional observational	Behavioural presentation of AD, developmental delay and developmental language disorder
	Werner 2005[316]	USA	Cross-sectional observational	Describing variations in early course of development
	Zachor 2010[335]	Israel	Longitudinal observational	To examine the effect of the intervention approach (ABA, eclectic) on outcome in cognitive, language, and adaptive skills and on changes in autism diagnosis categories

ABA, applied behavioural analysis; AD, autistic disorder; CLT, Conventional Language Therapy; DD, developmentally delayed; DLS, daily living skills; ESDM, Early Start Denver Model; FPI, Focused Playtime Intervention; GIFT, Group Intensive Family Training; PEBM, parent education and behaviour management intervention; PECS, Picture Exchange Communication System; PRT, Pivotal Response Treatment; RCT, randomised controlled trial; TD, typically developing.

Social communication	Paper	Location	Study design	Study aim
Autism Diagnostic Interview-Revised (ADI-R)	Ben Itzchak 2008[149]	Israel	Longitudinal observational	To examine the relations between cognition and autism severity, head size and intervention outcome
	Bennett 2012[304]	Canada	Longitudinal observational	Impact of maternal depression on mother's reports of her child's ASD behaviours
	Brian 2008[305]	Canada	Longitudinal observational	Assessment of potential behavioural markers of ASD at 18 months in a high-risk cohort of infant siblings of children with ASD
	Feldman 2012[104]	Canada	Longitudinal observational	Development and evaluation of a new instrument – POEMS
	Hambly 2012[306]	Canada	Cross-sectional observational	The impact of bilingual exposure on language learning in ASD
	Honey 2008[307]	UK	Longitudinal observational	The study tests the following specific hypotheses: 1. Repetitive behaviour items from the ADI-R will group into four factors as identified in ICD-10 2. Children with better ability will have fewer repetitive behaviours than those children with lesser ability 3. Children with better ability will demonstrate a different pattern of repetitive behaviours from children with lesser ability 4. Repetitive behaviours will increase over time in children with ASD
	Magiati 2007[308]	UK	Longitudinal observational	To provide data on long-term outcome for children with ASD who have received intensive, comprehensive interventions in their preschool years
	Magiati 2011[309]	UK	Longitudinal observational	To provide data on long-term outcome for children with ASD who have received intensive, comprehensive interventions in their preschool years
	Mayo 2013[310]	USA	Other – retrospective observational	This study examined the relationship between age of language acquisition and later functioning in children with ASD
	Mooney 2006[311]	Australia	Cross-sectional observational	Examined whether repetitive behaviours are a feature of autism in children aged < 51 months, independent of chronological or developmental age
	Munson 2008[312]	USA	Cross-sectional observational	Latent class analysis of IQ in ASD

Social communication	Paper	Location	Study design	Study aim
	Ozonoff 2010[313]	USA	Longitudinal observational	'To examine prospectively the emergence of behavioural signs of autism in the first years of life in infants at low and high risk for autism'
	Pry 2005[314]	France, Switzerland, Belgium and Luxembourg	Cross-sectional observational	The relationship between expressive language level and psychological development in children with autism 5 years of age
	Richler 2007[315]	USA	Longitudinal observational	Examination of RRBs
	Werner 2005[316]	USA	Cross-sectional observational	Describing variations in early course of development
Autism Diagnostic Observation Scale-Toddler Module (ADOS-T)	Rogers 2012[317]	USA	Intervention RCT	This study was carried out to examine the efficacy of a 12-week, low-intensity (1 hour per week of therapist contact), parent-delivered intervention for toddlers at risk for ASDs aged 14–24 months and their families
Autism Diagnostic Observation Schedule (ADOS)	Aldred 2004[318]	England	Intervention RCT	'Social communication intervention targeting parental communication'
	Aldred 2012[319]	UK	Other RCT	A mediation analysis aimed at assessing the impact of targeted intervention on autism characteristics
	Ben Itzchak 2008[149]	Israel	Longitudinal observational	To examine the relations between cognition and autism severity, head size and intervention outcome
	Ben Itzchak 2011[320]	Israel	Intervention quasi-experimental	The study explored child and parental characteristics at baseline that may predict outcomes in adaptive skills and acquisition of cognitive gains
	Bennett 2012[304]	Canada	Longitudinal observational	Impact of maternal depression on mother's reports of her child's ASD behaviours
	Brian 2008[305]	Canada	Longitudinal observational	Assessment of potential behavioural markers of ASD at 18 months in a high-risk cohort of infant siblings of children with ASD
	Dawson 2010[321]	USA	Intervention RCT	Efficacy of the ESDM, a comprehensive developmental behavioural intervention, for improving outcomes in ASD toddlers
	Gotham 2012[322]	USA	Longitudinal observational	To plot longitudinal trajectories of ASD severity from early childhood to early adolescence
	Green 2010[253]	UK	Intervention RCT	Early interventions for social communication

Social communication	Paper	Location	Study design	Study aim
	Hartley 2009[323]	USA	Cross-sectional observational	To explore developmental patterns, along gender lines, in children who have autism
	Landa 2012[224]	USA	Intervention quasi-experimental	Comprehensive early intervention
	Lerna 2012[325]	Italy	Intervention RCT	PECS vs. CLT
	Luyster 2008[129]	USA	Cross-sectional observational	To systematically investigate language in toddlers with ASD and to identify early correlates of receptive and expressive language in this population
	Munson 2008[312]	USA	Cross-sectional observational	Latent class analysis of IQ in ASD
	Oosterling 2010[326]	The Netherlands	Intervention RCT	Intervention is 'Focus parent training'. Home-based parent training promoting compliance, mutual enjoyment, joint attention and language development
	Ray-Subramanian 2011[327]	USA	Cross-sectional observational	'Their study examined adaptive behaviour and cognitive skills for 125 toddlers on the autism spectrum using the recently updated Vineland-II and Bayley-III'
	Ray-Subramanian 2012[328]	USA	Longitudinal observational	This study examined whether language skills and non-verbal cognitive skills were associated with clinician-observed RRBs in children with ASD
	Strauss 2012[329]	Italy	Intervention quasi-experimental	Influence of parent inclusion in treatment provision on child's progress
	Sullivan 2007[330]	USA	Longitudinal observational	To examine whether RJA was impaired as early as 14 months in children later diagnosed with ASD and whether RJA was an early marker for ASD diagnosis at outcome
	Tek 2012[331]	USA	Cross-sectional observational	To assess whether early symptom presentation differs in toddlers with ASD from ethnic minority vs. non-minority backgrounds
	Ventola 2007[332]	USA	Cross-sectional observational	Behavioural presentation of AD, developmental delay and developmental language disorder
	Werner 2005[316]	USA	Cross-sectional observational	Describing variations in early course of development
	Wong 2010[333]	China	Intervention RCT	To pilot a 2-week 'Autism 1-2-3' early intervention for children with autism and their parents immediately after diagnosis that targeted at (1) eye contact, (2) gesture and (3) vocalisation/words

Social communication	Paper	Location	Study design	Study aim
	Zachor 2006[334]	Israel	Intervention quasi-experimental	To compare the outcome of two centre-based intervention for autism
	Zachor 2010[335]	Israel	Longitudinal observational	To examine the effect of the intervention approach (ABA, eclectic) on outcome in cognitive, language, and adaptive skills and on changes in autism diagnosis categories
Autism Screening Instrument for Educational Planning (ASIEP)	Arick 2003[388]	USA	Cross-sectional observational	To track programme implementation variables and outcome data for students with ASDs engaged in school or home programmes
Communication and Symbolic Behavior Scales-Developmental Profile (CSBS-DP) Caregiver Questionnaire	Tek 2012[331]	USA	Cross-sectional observational	To assess whether early symptom presentation differs in toddlers with ASD from ethnic minority vs. non-minority backgrounds
Early Social Communication Scale (ESCS)	Dereu 2012[365]	Belgium	Longitudinal observational	Developmental trajectories of joint attention, imitation and pretend play impairments in autism
	Goods 2013[366]	USA	Intervention RCT	JASPER
	Ingersoll 2012[286]	USA	Intervention RCT	Imitation intervention to improve social functioning
	Kaale 2012[294]	Norway	Intervention RCT	To explore effectiveness of parent-mediated and specialist-mediated joint attention-intervention
	Kalas 2012[367]	USA	Cross-sectional observational	Joint attention responses to simple vs. complex music
	Kasari 2006[368]	USA	Intervention RCT	The efficacy of targeted interventions of joint attention and symbolic play was explored
	Lawton 2012[369]	USA	Intervention quasi-experimental	Joint attention
	Luyster 2008[129]	USA	Cross-sectional observational	To systematically investigate language in toddlers with ASD and to identify early correlates of receptive and expressive language in this population
	Paparella 2011[370]	USA	Longitudinal observational	Study 1: Cross-sectional study of profile of emergence of joint attention Study 2: Longitudinal study of emergence of joint attention
	Remington 2007[358]	UK	Intervention quasi-experimental	Comparison of early intensive behavioural interventions and treatment as usual

Social communication	Paper	Location	Study design	Study aim
	Roos 2008[371]	USA	Cross-sectional observational	Comparison of contexts for assessing joint attention in toddlers on the autism spectrum
	Wong 2013[373]	USA	Intervention RCT	The aim of this study was to pilot test a classroom-based intervention focused on facilitating play and joint attention for young children with autism in self-contained special education classrooms.
	Yoder 2006[374]	USA	Intervention RCT	Compared the efficacy of two communication interventions (RPMT and PECS) in 36 preschoolers with ASDs
	Salt 2002[372]	UK	Intervention quasi-experimental	Developmentally based early intervention programme
Early Social Communication Scales (ESCS)-Abridged	Yoder 2010[375]	USA	Intervention RCT	Effects of a social communication intervention
Pragmatics Profile	Roberts 2011[405]	Australia	Intervention RCT	Comparison of home-based vs. centre-based early intervention programmes
Social Communication Assessment for Toddlers with Autism (SCATA)	Drew 2007[137]	UK	Longitudinal observational	To describe the SCATA administration and scoring, to examine the pattern of developmental change in two samples of children with autism and PDD and to examine which aspects of early non-verbal communication are most strongly associated with later language outcomes
Social Communication Behavior Codes	Ozonoff 2010[313]	USA	Longitudinal observational	'To examine prospectively the emergence of behavioural signs of autism in the first years of life in infants at low and high risk for autism'
Vineland Adaptive Behavior Scales-Classroom Edition (VABS-Classroom)	Goin-Kochel 2007[427]	USA	Longitudinal observational	To assess the developmental trajectories of children with autism enrolled in ABA-based school
Vineland Adaptive Behavior Scales (VABS)	Aldred 2004[318]	England	Intervention RCT	'Social communication intervention targeting parental communication'
	Anan 2008[396]	USA	Other – quantitative case series	To examine the efficacy of the GIFT programme, a 12-week (180 hours, delivered 3 hours each weekday) parent-training for preschoolers with ASDs
	Andersson 2013[409]	Sweden	Longitudinal observational	To explore gender-related differences in ASD characteristics

Social communication	Paper	Location	Study design	Study aim
	Arick 2003[388]	USA	Cross-sectional observational	To track programme implementation variables and outcome data for students with ASDs engaged in school or home programmes
	Baghdadli 2012[339]	France	Longitudinal observational	Developmental trajectory of adaptive behaviours
	Bearss 2013[278]	USA	Longitudinal observational	To assess the feasibility and efficacy of a parent training programme
	Bennett 2008[296]	Canada	Longitudinal observational	To explore 'specific language impairment' as a predictor of children's symptom and functional outcome
	Carlsson 2013[390]	Sweden	Cross-sectional observational	To analyse co-occurring disorders and problems in a representative group of 198 preschool children with ASD
	Cassidy 2008[348]	Northern Ireland	Cross-sectional observational	To describe the demographic characteristics of preschoolers and their families; to discover parental perceptions of the child's difficulties; to identify the impact the child has on family life; to outline the supports available to families and those they would like to have
	Dawson 2010[321]	USA	Intervention RCT	Efficacy of the ESDM, a comprehensive developmental behavioural intervention, for improving outcomes in ASD toddlers
	Eikeseth 2009[410]	UK	Longitudinal observational	Effect of intensity of supervision on outcomes
	Eldevik 2012[414]	UK (Wales)	Longitudinal observational	Behavioural intervention outcome for children who had autism
	Eriksson 2013[415]	Sweden	Longitudinal observational	To explore frequency of other medical conditions in autism
	Gabriels 2007[416]	USA	Longitudinal observational	To assess the stability of adaptive functioning in two cognitive ability groups of children with an ASD
	Green 2010[253]	UK	Intervention RCT	Early interventions for social communication
	Grindle 2012[417]	UK (Wales)	Intervention quasi-experimental	ABA classroom: educational intervention in a mainstream school setting
	Hedvall 2013[418]	Sweden	Cross-sectional observational	Processing speed and adaptive function
	Herring 2006[411]	Australia	Longitudinal observational	To explore the impact of developmental disorders on children and their families

Social communication	Paper	Location	Study design	Study aim
	Honey 2008[307]	UK	Longitudinal observational	The study tests the following specific hypotheses: 1. Repetitive behaviour items from the ADI-R will group into four factors as identified in ICD-10 2. Children with better ability will have fewer repetitive behaviours than those children with lesser ability 3. Children with better ability will demonstrate a different pattern of repetitive behaviours from children with lesser ability 4. Repetitive behaviours will increase over time in children with ASD
	Hudry 2010[233]	UK	Cross-sectional observational	Recruited as part of Preschool Autism Communication Trial but this report is on baseline data for only receptive vs. expressive skills
	Ben Itzchak 2011[320]	Israel	Intervention quasi-experimental	The study explored child and parental characteristics at baseline that may predict outcomes in adaptive skills and acquisition of cognitive gains
	Jasmin 2009[384]	Canada	Cross-sectional observational	To determine the impact of sensory–motor DLS on the performance of DLS in preschool children with ASD
	Jonsdottir 2007[341]	Iceland	Longitudinal observational	The purpose of the present study was to describe stability and change of preschool children in Iceland and to contribute to the accumulation of data on outcome in autism
	Klintwall 2012[419]	Sweden	Longitudinal observational	Number and controllability of reinforces as predictors of outcomes for autistic children receiving early and intense behavioural intervention
	Landa 2012[224]	USA	Intervention quasi-experimental	Comprehensive early intervention
	Lerna 2012[325]	Italy	Intervention RCT	PECS vs. CLT
	Lloyd 2013[400]	USA	Cross-sectional observational	Gross and fine motor skills of young children with ASD
	Luyster 2008[129]	USA	Cross-sectional observational	To systematically investigate language in toddlers with ASD and to identify early correlates of receptive and expressive language in this population
	Magiati 2007[308]	UK	Longitudinal observational	To provide data on long-term outcome for children with ASD who have received intensive, comprehensive interventions in their preschool years

Social communication	Paper	Location	Study design	Study aim
	Magiati 2011[309]	UK	Longitudinal observational	To provide data on long-term outcome for children with ASD who have received intensive, comprehensive interventions in their preschool years
	Mayo 2013[310]	USA	Other – retrospective observational	This study examined the relationship between age of language acquisition and later functioning in children with ASD
	McConkey 2010[349]	–	Intervention quasi-experimental	Evaluate a home-based intervention for preschool children with a confirmed diagnosis of ASD
	Munson 2006[420]	USA	Longitudinal observational	The relationship between amygdalar volume at age 3–4 years and outcomes at age 6 years
	Munson 2008[312]	USA	Cross-sectional observational	Latent class analysis of IQ in ASD
	O'Donnell 2012[386]	USA	Cross-sectional observational	To explore sensory processing characteristics in preschool-age children with ASDs
	Eapen 2013[357]	Australia	Longitudinal observational	Evaluation of ESDM for preschool-aged children with ASD
	Osborne 2008[350]	UK	Intervention quasi-experimental	There was great heterogeneity among the interventions delivered and so for analysis interventions were categorised into high vs. low intensity
	Osborne 2009[351]	UK	Longitudinal observational	Evaluate relationship between child behaviour problems and parental stress
	Peters-Scheffer 2010[421]	The Netherlands	Intervention quasi-experimental	Behavioural treatment in preschool
	Poon 2012[401]	USA	Longitudinal observational	'The current study uses retrospective video analysis (RVA) methods to investigate the longitudinal trajectories of social-communicative behaviours, as well as their associations with later developmental outcomes'
	Pry 2005[314]	France, Switzerland, Belgium and Luxembourg	Cross-sectional observational	The relationship between expressive language level and psychological development in children with autism 5 years of age
	Ray-Subramanian 2011[327]	USA	Cross-sectional observational	'Their study examined adaptive behaviour and cognitive skills for 125 toddlers on the autism spectrum using the recently updated Vineland-II and Bayley-III'

Social communication	Paper	Location	Study design	Study aim
	Reed 2007[352]	UK	Longitudinal observational	Comparing high- and low-intensity interventions (with comparison of three different types of high-intensity interventions)
	Reed 2007[353]	UK	Longitudinal observational	Compare effectiveness of ABA, special nursery placements and portage; addressing limitations of previous studies by using the same measures at baseline and end point
	Reed 2012[354]	UK	Intervention quasi-experimental	To explore and document the relationships between severity of autism, temporal input of the programme, and the outcome effectiveness for a variety of early interventions for children on the autism spectrum. In particular, ABA, special nursery placement, an adaptation of a portage approach for individuals on the autism spectrum, and an eclectic approach developed by a local authority were chosen for study
	Remington 2007[358]	UK	Intervention quasi-experimental	Comparison of early intensive behavioural interventions and treatment as usual
	Restall 1994[422]	Canada	Cross-sectional observational	How does the play of children with autism differ that of normally developing children? What are the relationships between performance and adaptive abilities?
	Rickards 2009[423]	Australia	Intervention RCT	Does home-based programme provided over 12 months result in sustained improvement in development and behaviour?
	Roberts 2011[405]	Australia	Intervention RCT	Comparison of home-based vs. centre-based early intervention programmes
	Rogers 2012[317]	USA	Intervention RCT	This study was carried out to examine the efficacy of a 12-week, low-intensity (1 hour per week of therapist contact), parent-delivered intervention for toddlers at risk for ASDs aged 14–24 months and their families
	Ruble 2008[424]	USA	Cross-sectional observational	Effect of caregiver responsiveness on child cognitive and social interactions
	Salt 2002[372]	UK	Intervention quasi-experimental	Developmentally based early intervention programme

Social communication	Paper	Location	Study design	Study aim
	Schertz 2013[402]	USA	Intervention RCT	The purpose of this study was to determine effects of the JAML intervention on acquisition of joint attention and other early social communication competencies for toddlers with ASDs
	Silva 2007[299]	USA	Intervention RCT	Effectiveness of qigong massage methodology, in treating sensory impairment in young children with autism
	Silva 2008[300]	USA	Intervention RCT	Outcomes of pilot of qigong sensory training programme
	Smith 2000[413]	USA	Intervention RCT	Comparing intensive treatment group to parent training group
	Smith 2010[359]	Canada and USA	Intervention quasi-experimental	Effect of a parent training and naturalistic one-to-one behaviour intervention using PRT on language, behaviour and ASD symptoms
	Stahmer 2004[355]	USA	Intervention quasi-experimental	To analyse the outcomes for 20 young children with ASD in an inclusive programme for children aged < 3 years
	Stone 1999[346]	USA	Cross-sectional observational	Patterns of adaptive behaviour in young children with ASD
	Strauss 2012[329]	Italy	Intervention quasi-experimental	Influence of parent inclusion in treatment provision on child's progress
	Szatmari 2000[302]	Canada	Longitudinal observational	Monitoring cognitive and language outcomes of groups of children with autism and Asperger syndrome
	Tonge 2012[425]	Australia	Longitudinal observational	To determine the impact of a PEBM on the mental health and adjustment of parents with preschool children with autism
	Toth 2006[284]	USA	Longitudinal observational	This study investigated the unique contributions of joint attention, imitation, and toy play to language ability and rate of development of communication skills in young children with ASD
	VanMeter 1997[426]	USA	Cross-sectional observational	Social, communication and DLS was examined for autistic children, compared with retarded and normal controls
	Ventola 2007[332]	USA	Cross-sectional observational	Behavioural presentation of AD, developmental delay and developmental language disorder
	Werner 2005[316]	USA	Cross-sectional observational	Describing variations in early course of development

Social communication	Paper	Location	Study design	Study aim
	Zachor 2010[335]	Israel	Longitudinal observational	To examine the effect of the intervention approach (ABA, eclectic) on outcome in cognitive, language, and adaptive skills and on changes in autism diagnosis categories
Parent Survey[a]	Arick 2003[388]	USA	Cross-sectional observational	To track programme implementation variables and outcome data for students with ASDs engaged in school or home programmes
Caregiver–child interaction[b]	Kasari 2006[368]	USA	Intervention RCT	The efficacy of targeted interventions of joint attention and symbolic play was explored
Classroom and playground behaviour observations[b]	Escalona 2001[271]	USA	Intervention RCT	To explore the effectiveness of massage therapy on stereotypic behaviour among children diagnosed with autism
Coding of initiation of joint attention[b]	Ingersoll 2012[286]	USA	Intervention RCT	Imitation intervention to improve social functioning
Examiner ratings of social engagement[b]	Ozonoff 2010[313]	USA	Longitudinal observational	'To examine prospectively the emergence of behavioural signs of autism in the first years of life in infants at low and high risk for autism'
Parent–child interaction[b]	Green 2010[253]	UK	Intervention RCT	Early interventions for social communication
Parent–Child Interaction measure[b]	Aldred 2012[319]	UK	Other – a RCT	A mediation analysis aimed at assessing the impact of targeted intervention on autism characteristics
Preschool teacher–child play[b]	Kaale 2012[294]	Norway	Intervention RCT	To explore effectiveness of parent-mediated and specialist-mediated joint attention-intervention
Unstructured free play with examiner[b]	Lerna 2012[325]	Italy	Intervention RCT	PECS vs. CLT
Video coding procedures[b]	Colgan 2006[379]	USA	Longitudinal observational	To examine the frequency, initiation, prompting and diversity of types of gestures used for social interaction purposes
Video recording of child in classroom activities[b]	Ingersoll 2001[380]	USA	Longitudinal observational	To identify a behavioural characteristic that may affect the outcome of a particular treatment model

ABA, applied behavioural analysis; AD, autistic disorder; CLT, Conventional Language Therapy; DLS, daily living skills; ESDM, Early Start Denver Model; GIFT, Group Intensive Family Training; JAML, Joint Attention Mediated Learning; JASPER, Joint Attention Symbolic Play Engagement and Regulation; PEBM, parent education and behaviour management intervention; PECS, Picture Exchange Communication System; PRT, Pivotal Response Treatment; RCT, randomised controlled trial; RJA, response to joint attention; RPMT, Responsive Education and Prelinguistic Milieu Teaching.
a Tools developed ad hoc.
b Observational coding.

Social functioning	Paper	Location	Study design	Study aim
Autism Diagnostic Interview-Revised (ADI-R)	Ben Itzchak 2008[149]	Israel	Longitudinal observational	To examine the relations between cognition and autism severity, head size and intervention outcome
	Bennett 2012[304]	Canada	Longitudinal observational	Impact of maternal depression on mother's reports of her child's ASD behaviours
	Brian 2008[305]	Canada	Longitudinal observational	Assessment of potential behavioural markers of ASD at 18 months in a high-risk cohort of infant siblings of children with ASD
	Feldman 2012[104]	Canada	Longitudinal observational	Development and evaluation of a new instrument – POEMS
	Hambly 2012[306]	Canada	Cross-sectional observational	The impact of bilingual exposure on language learning in ASD
	Honey 2008[307]	UK	Longitudinal observational	The study tests the following specific hypotheses: 1. Repetitive behaviour items from the ADI-R will group into four factors as identified in ICD-10 2. Children with better ability will have fewer repetitive behaviours than those children with lesser ability 3. Children with better ability will demonstrate a different pattern of repetitive behaviours from children with lesser ability 4. Repetitive behaviours will increase over time in children with ASD
	Magiati 2007[308]	UK	Longitudinal observational	To provide data on long-term outcome for children with ASD who have received intensive, comprehensive interventions in their preschool years
	Magiati 2011[309]	UK	Longitudinal observational	To provide data on long-term outcome for children with ASD who have received intensive, comprehensive interventions in their preschool years
	Mayo 2013[310]	USA	Other – retrospective observational	This study examined the relationship between age of language acquisition and later functioning in children with ASD
	Mooney 2006[311]	Australia	Cross-sectional observational	Examined whether repetitive behaviours are a feature of autism in children aged < 51 months, independent of chronological or developmental age
	Munson 2008[312]	USA	Cross-sectional observational	Latent class analysis of IQ in ASD

Social functioning	Paper	Location	Study design	Study aim
	Ozonoff 2010[313]	USA	Longitudinal observational	'To examine prospectively the emergence of behavioural signs of autism in the first years of life in infants at low and high risk for autism'
	Pry 2005[314]	France, Switzerland, Belgium and Luxembourg	Cross-sectional observational	The relationship between expressive language level and psychological development in children with autism 5 years of age
	Richler 2007[315]	USA	Longitudinal observational	Examination of RRBs
	Werner 2005[316]	USA	Cross-sectional observational	Describing variations in early course of development
Child Behavior Scale (CBS)	Jahromi 2013[431]	USA	Longitudinal observational	The importance of self-regulation for the school and peer engagement of children with high-functioning autism
	Meek 2012[435]	USA	Cross-sectional observational	To examine group differences in discrete dimensions of social competence between high-functioning autism children and their typically developing peers
Nisonger Child Behavior Rating Scales	Remington 2007[358]	UK	Intervention quasi-experimental	Comparison of early intensive behavioural interventions and treatment as usual
Social Behavior Rating Scale	Vorgraft 2007[347]	Israel	Cross-sectional observational	Effectiveness of the 'Mifne Centre' approach to PDD
Vineland Adaptive Behavior Scales-Classroom Edition (VABS-Classroom)	Goin-Kochel 2007[427]	USA	Longitudinal observational	To assess the developmental trajectories of children with autism enrolled in ABA-based school
Vineland Adaptive Behavior Scales (VABS)	Aldred 2004[318]	England	Intervention RCT	'Social communication intervention targeting parental communication'
	Anan 2008[396]	USA	Other – quantitative case series	To examine the efficacy of the GIFT programme, a 12-week (180 hours, delivered 3 hours each weekday) parent-training for preschoolers with ASDs
	Andersson 2013[409]	Sweden	Longitudinal observational	To explore gender-related differences in ASD characteristics
	Arick 2003[388]	USA	Cross-sectional observational	To track programme implementation variables and outcome data for students with ASDs engaged in school or home programmes
	Baghdadli 2012[339]	France	Longitudinal observational	Developmental trajectory of adaptive behaviours
	Bearss 2013[278]	USA	Longitudinal observational	To assess the feasibility and efficacy of a parent training programme
	Bennett 2008[296]	Canada	Longitudinal observational	To explore 'specific language impairment' as a predictor of children's symptom and functional outcome

Social functioning	Paper	Location	Study design	Study aim
	Carlsson 2013[390]	Sweden	Cross-sectional observational	To analyse co-occurring disorders and problems in a representative group of 198 preschool children with ASD
	Cassidy 2008[348]	Northern Ireland	Cross-sectional observational	To describe the demographic characteristics of preschoolers and their families; to discover parental perceptions of the child's difficulties; to identify the impact the child has on family life; to outline the supports available to families and those they would like to have
	Dawson 2010[321]	USA	Intervention RCT	Efficacy of the ESDM, a comprehensive developmental behavioural intervention, for improving outcomes in ASD toddlers
	Eikeseth 2009[410]	UK	Longitudinal observational	Effect of intensity of supervision on outcomes
	Eldevik 2012[414]	UK (Wales)	Longitudinal observational	Behavioural intervention outcome for children who had autism
	Eriksson 2013[415]	Sweden	Longitudinal observational	To explore frequency of other medical conditions in autism
	Gabriels 2007[416]	USA	Longitudinal observational	To assess the stability of adaptive functioning in two cognitive ability groups of children with an ASD
	Green 2010[253]	UK	Intervention RCT	Early interventions for social communication
	Grindle 2012[417]	UK (Wales)	Intervention quasi-experimental	ABA classroom: educational intervention in a mainstream school setting
	Hedvall 2013[418]	Sweden	Cross-sectional observational	Processing speed and adaptive function
	Herring 2006[411]	Australia	Longitudinal observational	To explore the impact of developmental disorders on children and their families
	Honey 2008[307]	UK	Longitudinal observational	The study tests the following specific hypotheses: 1. Repetitive behaviour items from the ADI-R will group into four factors as identified in ICD-10 2. Children with better ability will have fewer repetitive behaviours than those children with lesser ability 3. Children with better ability will demonstrate a different pattern of repetitive behaviours from children with lesser ability 4. Repetitive behaviours will increase over time in children with ASD

Social functioning	Paper	Location	Study design	Study aim
	Hudry 2010[233]	UK	Cross-sectional observational	Recruited as part of Preschool Autism Communication Trial but this report is on baseline data for only receptive vs. expressive skills
	Ben Itzchak 2011[320]	Israel	Intervention quasi-experimental	The study explored child and parental characteristics at baseline that may predict outcomes in adaptive skills and acquisition of cognitive gains
	Jasmin 2009[384]	Canada	Cross-sectional observational	To determine the impact of sensory–motor DLS on the performance of DLS in preschool children with ASD
	Jonsdottir 2007[341]	Iceland	Longitudinal observational	The purpose of the present study was to describe stability and change of preschool children in Iceland and to contribute to the accumulation of data on outcome in autism
	Klintwall 2012[419]	Sweden	Longitudinal observational	Number and controllability of reinforces as predictors of outcomes for autistic children receiving early and intense behavioural intervention
	Landa 2012[224]	USA	Intervention quasi-experimental	Comprehensive early intervention
	Lerna 2012[325]	Italy	Intervention RCT	PECS vs. CLT
	Lloyd 2013[400]	USA	Cross-sectional observational	Gross and fine motor skills of young children with ASD
	Luyster 2008[129]	USA	Cross-sectional observational	To systematically investigate language in toddlers with ASD and to identify early correlates of receptive and expressive language in this population
	Magiati 2007[308]	UK	Longitudinal observational	To provide data on long-term outcome for children with ASD who have received intensive, comprehensive interventions in their preschool years
	Magiati 2011[309]	UK	Longitudinal observational	To provide data on long-term outcome for children with ASD who have received intensive, comprehensive interventions in their preschool years
	Mayo 2013[310]	USA	Other – retrospective observational	This study examined the relationship between age of language acquisition and later functioning in children with ASD
	McConkey 2010[349]	–	Intervention quasi-experimental	Evaluate a home-based intervention for preschool children with a confirmed diagnosis of ASD
	Munson 2006[420]	USA	Longitudinal observational	The relationship between amygdalar volume at age 3–4 years and outcomes at age 6 years

Social functioning	Paper	Location	Study design	Study aim
	Munson 2008[312]	USA	Cross-sectional observational	Latent class analysis of IQ in ASD
	O'Donnell 2012[386]	USA	Cross-sectional observational	To explore sensory processing characteristics in preschool-age children with ASDs
	Eapen 2013[357]	Australia	Longitudinal observational	Evaluation of ESDM for preschool-aged children with ASD
	Osborne 2008[350]	UK	Intervention quasi-experimental	There was great heterogeneity among the interventions delivered and so for analysis interventions were categorised into high vs. low intensity
	Osborne 2009[351]	UK	Longitudinal observational	Evaluate relationship between child behaviour problems and parental stress
	Peters-Scheffer 2010[421]	The Netherlands	Intervention quasi-experimental	Behavioural treatment in preschool
	Poon 2012[401]	USA	Longitudinal observational	'The current study uses retrospective video analysis (RVA) methods to investigate the longitudinal trajectories of social-communicative behaviours, as well as their associations with later developmental outcomes'
	Pry 2005[314]	France, Switzerland, Belgium and Luxembourg	Cross-sectional observational	The relationship between expressive language level and psychological development in children with autism 5 years of age
	Ray-Subramanian 2011[327]	USA	Cross-sectional observational	'Their study examined adaptive behaviour and cognitive skills for 125 toddlers on the autism spectrum using the recently updated Vineland-II and Bayley-III'
	Reed 2007[352]	UK	Longitudinal observational	Comparing high- and low-intensity interventions (with comparison of three different types of high-intensity interventions)
	Reed 2007[353]	UK	Longitudinal observational	Compare effectiveness of ABA, special nursery placements and portage; addressing limitations of previous studies by using the same measures at baseline and end point
	Reed 2012[354]	UK	Intervention quasi-experimental	To explore and document the relationships between severity of autism, temporal input of the programme and the outcome effectiveness for a variety of early interventions for children on the autism spectrum. In particular, ABA, special nursery placement, an adaptation of a portage approach for individuals on the autism spectrum, and an eclectic approach developed by a local authority were chosen for study

Social functioning	Paper	Location	Study design	Study aim
	Remington 2007[358]	UK	Intervention quasi-experimental	Comparison of early intensive behavioural interventions and treatment as usual
	Restall 1994[422]	Canada	Cross-sectional observational	How does the play of children with autism differ that of normally developing children? What are the relationships between performance and adaptive abilities?
	Rickards 2009[423]	Australia	Intervention RCT	Does home-based programme provided over 12 months result in sustained improvement in development and behaviour?
	Roberts 2011[405]	Australia	Intervention RCT	Comparison of home-based vs. centre-based early intervention programmes
	Rogers 2012[317]	USA	Intervention RCT	This study was carried out to examine the efficacy of a 12-week, low-intensity (1 hour per week of therapist contact), parent-delivered intervention for toddlers at risk for ASDs aged 14–24 months and their families
	Ruble 2008[424]	USA	Cross-sectional observational	Effect of caregiver responsiveness on child cognitive and social interactions
	Salt 2002[372]	UK	Intervention quasi-experimental	Developmentally based early intervention programme
	Schertz 2013[402]	USA	Intervention RCT	The purpose of this study was to determine effects of the JAML intervention on acquisition of joint attention and other early social communication competencies for toddlers with ASDs
	Silva 2007[299]	USA	Intervention RCT	Effectiveness of qigong massage methodology, in treating sensory impairment in young children with autism
	Silva 2008[300]	USA	Intervention RCT	Outcomes of pilot of qigong sensory training programme
	Smith 2000[413]	USA	Intervention RCT	Comparing intensive treatment group to parent training group
	Smith 2010[359]	Canada and USA	Intervention quasi-experimental	Effect of a parent training and naturalistic one-to-one behaviour intervention using PRT on language, behaviour and ASD symptoms
	Stahmer 2004[355]	USA	Intervention quasi-experimental	To analyse the outcomes for 20 young children with ASD in an inclusive programme for children aged < 3 years
	Stone 1999[346]	USA	Cross-sectional observational	Patterns of adaptive behaviour in young children with ASD
	Strauss 2012[329]	Italy	Intervention quasi-experimental	Influence of parent inclusion in treatment provision on child's progress

Social functioning	Paper	Location	Study design	Study aim
	Szatmari 2000[302]	Canada	Longitudinal observational	Monitoring cognitive and language outcomes of groups of children with autism and Asperger syndrome
	Tonge 2012[425]	Australia	Longitudinal observational	To determine the impact of a PEBM on the mental health and adjustment of parents with preschool children with autism
	Toth 2006[284]	USA	Longitudinal observational	This study investigated the unique contributions of joint attention, imitation, and toy play to language ability and rate of development of communication skills in young children with ASD
	VanMeter 1997[426]	USA	Cross-sectional observational	Social, communication and DLS was examined for autistic children, compared with retarded and normal controls
	Ventola 2007[332]	USA	Cross-sectional observational	Behavioural presentation of AD, developmental delay and developmental language disorder
	Werner 2005[316]	USA	Cross-sectional observational	Describing variations in early course of development
	Zachor 2010[335]	Israel	Longitudinal observational	To examine the effect of the intervention approach (ABA, eclectic) on outcome in cognitive, language, and adaptive skills and on changes in autism diagnosis categories
Vineland Social Maturity Scale, Indian adaptation[a]	Malhi 2011[342]	India	Longitudinal observational	To assess diagnostic stability of autism diagnosis in children aged ≤ 3 years
Parent Survey[b]	Arick 2003[388]	USA	Cross-sectional observational	To track programme implementation variables and outcome data for students with ASDs engaged in school or home programmes
Classroom and playground behaviour observations[c]	Escalona 2001[271]	USA	Intervention RCT	To explore the effectiveness of massage therapy on stereotypic behaviour among children diagnosed with autism
Coded observation of social behaviour[c]	Meirsschaut 2011[442]	Belgium	Cross-sectional observational	Assessment of ASD vs. TD mother–child dyads and mothers–unfamiliar child dyad interactions
Video recording of child in classroom activities[c]	Ingersoll 2001[380]	USA	Longitudinal observational	To identify a behavioural characteristic that may affect the outcome of a particular treatment model

ABA, applied behavioural analysis; AD, autistic disorder; CLT, Conventional Language Therapy; DLS, daily living skills, ESDM, Early Start Denver Model; GIFT, Group Intensive Family Training; JAML, Joint Attention Mediated Learning; PEBM, parent education and behaviour management intervention; PECS, Picture Exchange Communication System; PRT, Pivotal Response Treatment; RCT, randomised controlled trial; TD, typically developing.
a Non-UK.
b Tools developed ad hoc.
c Observational coding.

Play	Paper	Location	Study design	Study aim
Autism Diagnostic Observation Scale-Toddler Module (ADOS-T)	Rogers 2012[317]	USA	Intervention RCT	This study was carried out to examine the efficacy of a 12-week, low-intensity (1 hour per week of therapist contact), parent-delivered intervention for toddlers at risk for ASDs aged 14–24 months and their families
Autism Diagnostic Observation Schedule (ADOS)	Aldred 2004[318]	England	Intervention RCT	'Social communication intervention targeting parental communication'
	Aldred 2012[319]	UK	Other RCT	A mediation analysis aimed at assessing the impact of targeted intervention on autism characteristics
	Ben Itzchak 2008[149]	Israel	Longitudinal observational	To examine the relations between cognition and autism severity, head size and intervention outcome
	Ben Itzchak 2011[320]	Israel	Intervention quasi-experimental	The study explored child and parental characteristics at baseline that may predict outcomes in adaptive skills and acquisition of cognitive gains
	Bennett 2012[304]	Canada	Longitudinal observational	Impact of maternal depression on mother's reports of her child's ASD behaviours
	Brian 2008[305]	Canada	Longitudinal observational	Assessment of potential behavioural markers of ASD at 18 months in a high-risk cohort of infant siblings of children with ASD
	Dawson 2010[321]	USA	Intervention RCT	Efficacy of the ESDM, a comprehensive developmental behavioural intervention, for improving outcomes in ASD toddlers
	Gotham 2012[322]	USA	Longitudinal observational	To plot longitudinal trajectories of ASD severity from early childhood to early adolescence
	Green 2010[253]	UK	Intervention RCT	Early interventions for social communication
	Hartley 2009[323]	USA	Cross-sectional observational	To explore developmental patterns, along gender lines, in children who have autism
	Landa 2012[224]	USA	Intervention quasi-experimental	Comprehensive early intervention
	Lerna 2012[325]	Italy	Intervention RCT	PECS vs. CLT
	Luyster 2008[129]	USA	Cross-sectional observational	To systematically investigate language in toddlers with ASD and to identify early correlates of receptive and expressive language in this population

Play	Paper	Location	Study design	Study aim
	Oosterling 2010[326]	The Netherlands	Intervention RCT	Intervention is 'Focus parent training'. Home-based parent training promoting compliance, mutual enjoyment, joint attention and language development
	Ray-Subramanian 2011[327]	USA	Cross-sectional observational	'Their study examined adaptive behaviour and cognitive skills for 125 toddlers on the autism spectrum using the recently updated Vineland-II and Bayley-III'
	Ray-Subramanian 2012[328]	USA	Longitudinal observational	This study examined whether or not language skills and non-verbal cognitive skills were associated with clinician-observed RRBs in children with ASD
	Strauss 2012[329]	Italy	Intervention quasi-experimental	Influence of parent inclusion in treatment provision on child's progress
	Sullivan 2007[330]	USA	Longitudinal observational	To examine whether RJA was impaired as early as 14 months in children later diagnosed with ASD and whether RJA was an early marker for ASD diagnosis at outcome
Autism Diagnostic Observation Schedule (ADOS)	Werner 2005[316]	USA	Cross-sectional observational	Describing variations in early course of development
	Wong 2010[333]	China	Intervention RCT	To pilot a 2-week 'Autism 1-2-3' early intervention for children with autism and their parents immediately after diagnosis that targeted at (1) eye contact, (2) gesture and (3) vocalisation/words
	Zachor 2006[334]	Israel	Intervention quasi-experimental	To compare the outcome of two centre-based intervention for autism
	Zachor 2010[335]	Israel	Longitudinal observational	To examine the effect of the intervention approach (ABA, eclectic) on outcome in cognitive, language, and adaptive skills and on changes in autism diagnosis categories
Autism Diagnostic Observation Schedule-Generic (ADOS-G)	Munson 2008[312]	USA	Cross-sectional observational	Latent class analysis of IQ in ASD
	Tek 2012[331]	USA	Cross-sectional observational	To assess whether early symptom presentation differs in toddlers with ASD from ethnic minority vs. non-minority backgrounds
	Ventola 2007[332]	USA	Cross-sectional observational	Behavioural presentation of AD, developmental delay and developmental language disorder

Play	Paper	Location	Study design	Study aim
Communication and Symbolic Behavior Scales Developmental Profile Caregiver Questionnaire	Tek 2012[331]	USA	Cross-sectional observational	To assess whether early symptom presentation differs in toddlers with ASD from ethnic minority vs. non-minority backgrounds
Developmental Play Assessment (DPA), Instrument Sequence of Categories	Freeman 2013[443]	USA	Cross-sectional observational	Parent–child play
Structured Play Assessment	Freeman 2013[443]	USA	Cross-sectional observational	Parent–child play
	Goods 2013[366]	USA	Intervention RCT	JASPER
	Kasari 2006[368]	USA	Intervention RCT	The efficacy of targeted interventions of joint attention and symbolic play was explored
Symbolic Play Test	Wong 2010[333]	China	Intervention RCT	To pilot a 2-week 'Autism 1-2-3' early intervention for children with autism and their parents immediately after diagnosis that targeted at (1) eye contact, (2) gesture and (3) vocalisation/ words
	Salt 2002[372]	UK	Intervention quasi-experimental	Developmentally based early intervention programme
	Magiati 2007[308]	UK	Longitudinal observational	To provide data on long-term outcome for children with ASD who have received intensive, comprehensive interventions in their preschool years
Test of Pretend Play (ToPP)	Magiati 2007[308]	UK	Longitudinal observational	To provide data on long-term outcome for children with ASD who have received intensive, comprehensive interventions in their preschool years
	Dereu 2012[365]	Belgium	Longitudinal observational	Developmental trajectories of joint attention, imitation and pretend play impairments in autism
Preschool Play Scale[a]	Restall 1994[422]	Canada	Cross-sectional observational	How does the play of children with autism differ that of normally developing children? What are the relationships between performance and adaptive abilities?
Caregiver–child interaction[b]	Kasari 2006[368]	USA	Intervention RCT	The efficacy of targeted interventions of joint attention and symbolic play was explored
Coded observation of social behaviour[b]	Meirsschaut 2011[442]	Belgium	Cross-sectional observational	Assessment of ASD vs. TD mother–child dyads and mothers–unfamiliar child dyad interactions

Play	Paper	Location	Study design	Study aim
Coding of videos[b]	Flippin 2011[406]	USA	Longitudinal observational	To investigate the concurrent relationships between the verbal and play responsiveness of 16 mothers and fathers and the object play skills of 16 children with ASDs
Free play assessment[b]	Christensen 2010[444]	USA	Cross-sectional observational	Assessing the relationship between play behaviours at 18 months and developmental outcomes in infant siblings of autistic children
Parent–child free play[b]	Freeman 2013[443]	USA	Cross-sectional observational	Parent–child play

ABA, applied behavioural analysis; CLT, Conventional Language Therapy; ESDM, Early Start Denver Model; PECS, Picture Exchange Communication System; RCT, randomised controlled trial; RJA, response to joint attention; TD, typically developing.

a Pre-1995.

b Observational coding.

Behaviour	Paper	Location	Study design	Study aim
Aberrant Behavior Checklist (ABC)	Baghdadli 2012[339]	France	Longitudinal observational	Developmental trajectory of adaptive behaviours
	Bearss 2013[278]	USA	Longitudinal observational	To assess the feasibility and efficacy of a parent training programme
	O'Donnell 2012[386]	USA	Cross-sectional observational	To explore sensory processing characteristics in preschool-age children with ASDs
	Werner 2005[316]	USA	Cross-sectional observational	Describing variations in early course of development
Baby and Infant Screen for Children with aUtIsm Traits (BISCUIT-Part 3)	Rojahn 2009[445]	USA	Cross-sectional observational	Frequency and patterns of various challenging behaviours were evaluated
Behaviour Assessment System for Children-Second Edition (BASC-2)	Hill-Chapman 2013[434]	USA	Cross-sectional observational	Parenting stress
Behavior Screening Questionnaire	Rickards 2009[423]	Australia	Intervention RCT	Does home-based programme provided over 12 months result in sustained improvement in development and behaviour?
Child Behavior Checklist (CBCL)	Baker 2010[397]	USA	Longitudinal observational	'Examined parent behaviour during unstructured play sessions with high- and low-risk toddlers who did or did not receive later ASD diagnoses, and investigated associations with concurrent child behaviour problems and later language growth'
	Hartley 2009[323]	USA	Cross-sectional observational	To explore developmental patterns, along gender lines, in children who have autism
	Peters-Scheffer 2010[421]	The Netherlands	Intervention quasi-experimental	Behavioural treatment in preschool
	Smith 2000[413]	USA	Intervention RCT	Comparing intensive treatment group to parent training group
	Smith 2010[359]	Canada and USA	Intervention quasi-experimental	Effect of a parent training and naturalistic one-to-one behaviour intervention using PRT on language, behaviour and ASD symptoms
	Taylor 2012[436]	USA	Longitudinal observational	To examine the reported symptoms and correlates of depression in caregivers of young children following ASD diagnosis
Child Behavior Scale (CBS)	Jahromi 2013[431]	USA	Longitudinal observational	The importance of self-regulation for the school and peer engagement of children with high-functioning autism
	Meek 2012[435]	USA	Cross-sectional observational	To examine group differences in discrete dimensions of social competence between high-functioning autism children and their typically developing peers

Behaviour	Paper	Location	Study design	Study aim
Conners Rating Scales-Revised	Escalona 2001[271]	USA	Intervention RCT	To explore the effectiveness of massage therapy on stereotypic behaviour among children diagnosed with autism
	Osborne 2009[351]	UK	Longitudinal observational	Evaluate relationship between child behaviour problems and parental stress
	Reed 2007[353]	UK	Longitudinal observational	Compare effectiveness of ABA, special nursery placements and portage; addressing limitations of previous studies by using the same measures at baseline and end point
	Reed 2013[437]	UK	Cross-sectional observational	The study assessed whether teacher and parent ratings of child behaviour problems were similar for children with ASDs
Developmental Behaviour Checklist	Herring 2006[411]	Australia	Longitudinal observational	To explore the impact of developmental disorders on children and their families
	Mooney 2006[311]	Australia	Cross-sectional observational	Examined whether repetitive behaviours are a feature of autism in children aged < 51 months, independent of chronological or developmental age
	Remington 2007[358]	UK	Intervention quasi-experimental	Comparison of early intensive behavioural interventions and treatment as usual
	Roberts 2011[405]	Australia	Intervention RCT	Comparison of home-based vs. centre-based early intervention programmes
	Tonge 2012[425]	Australia	Longitudinal observational	To determine the impact of a PEBM on the mental health and adjustment of parents with preschool children with autism
Home Situations Questionnaire (HSQ)	Bearss 2013[278]	USA	Longitudinal observational	To assess the feasibility and efficacy of a parent training programme
Nisonger Child Behavior Rating Scales	Remington 2007[358]	UK	Intervention quasi-experimental	Comparison of early intensive behavioural interventions and treatment as usual
Parent Target Problems	Bearss 2013[278]	USA	Longitudinal observational	To assess the feasibility and efficacy of a parent training programme
Pre-School Behavior Checklist	Rickards 2009[423]	Australia	Intervention RCT	Does home-based programme provided over 12 months resulted in sustained improvement in development and behaviour?

Behaviour	Paper	Location	Study design	Study aim
Behaviour Style Questionnaire – Chinese version[a]	Chuang 2012[383]	Taiwan	Cross-sectional observational	To explore relationships between sensory processing and a difficult temperament characteristics in children with autism
Coded observation of child behaviour problems[b]	Robbins 1992[446]	USA	Longitudinal observational	Investigating the effects of task difficulty on child behaviour problems
Functional behaviour assessment interview[c]	Reese 2005[447]	USA	Cross-sectional observational	'Examining the functions of disruptive behaviour in young children with autism compared with developmentally delayed children without autism matched for sex, developmental age, and chronological age'
Parent survey[c]	Arick 2003[388]	USA	Cross-sectional observational	To track programme implementation variables and outcome data for students with ASDs engaged in school or home programmes
Video coding procedures (for children and parents)[d]	Bryce 2013[448]	USA	Longitudinal observational	To examine children's compliance and non-compliance behaviours in response to parental control strategies

ABA, applied behavioural analysis; PEBM, parent education and behaviour management intervention; PRT, Pivotal Response Treatment; RCT, randomised controlled trial.
a Non-UK.
b Pre-1995.
c Tools developed ad hoc.
d Observational coding.

Habit problems	Paper	Location	Study design	Study aim
Child Behavior Checklist (CBCL)	Smith 2000[413]	USA	Intervention RCT	Comparing intensive treatment group to parent training group
	Baker 2010[397]	USA	Longitudinal observational	'Examined parent behaviour during unstructured play sessions with high- and low-risk toddlers who did or did not receive later ASD diagnoses, and investigated associations with concurrent child behaviour problems and later language growth'
	Peters-Scheffer 2010[421]	The Netherlands	Intervention quasi-experimental	Behavioural treatment in preschool
	Smith 2010[359]	Canada and USA	Intervention quasi-experimental	Effect of a parent training and naturalistic one-to-one behaviour intervention using PRT on language, behaviour and ASD symptoms
	Taylor 2012[436]	USA	Longitudinal observational	To examine the reported symptoms and correlates of depression in caregivers of young children following ASD diagnosis
	Hartley 2009[323]	USA	Cross-sectional observational	To explore developmental patterns, along gender lines, in children who have autism
Sense and Self-Regulation Checklist (SSC)	Silva 2009[226]	USA	Intervention RCT	Improvement following a qigong massage intervention
	Silva 2011[301]	USA	Intervention RCT	Dual parent and trainer-delivered qigong massage intervention for measures of autism, abnormal sensory responses and self-regulation
Sleep diaries[a]	Escalona 2001[271]	USA	Intervention RCT	To explore the effectiveness of massage therapy on stereotypic behaviour among children diagnosed with autism

PRT, Pivotal Response Treatment; RCT, randomised controlled trial.
a Tools developed ad hoc.

Learning	Paper	Location	Study design	Study aim
Autism Screening Instrument for Educational Planning (ASIEP)	Arick 2003[388]	USA	Cross-sectional observational	To track programme implementation variables and outcome data for students with ASDs engaged in school or home programmes
Extended Basic Academic Skills Assessment System	Arick 2003[388]	USA	Cross-sectional observational	To track programme implementation variables and outcome data for students with ASDs engaged in school or home programmes
Wechsler Individualised Achievement Test	Smith 2000[413]	USA	Intervention RCT	Comparing intensive treatment group to parent training group
Student Learning Profile[a]	Arick 2003[388]	USA	Cross-sectional observational	To track programme implementation variables and outcome data for students with ASDs engaged in school or home programmes
Classroom Observation Form[b]	Arick 2003[388]	USA	Cross-sectional observational	To track programme implementation variables and outcome data for students with ASDs engaged in school or home programmes

RCT, randomised controlled trial.
a Tools developed ad hoc.
b Observational coding.

Daily living skills	Paper	Location	Study design	Study aim
Functional Independence Measure for children (WeeFIM)	Jasmin 2009[384]	Canada	Cross-sectional observational	To determine the impact of sensory–motor DLS on the performance of DLS in preschool children with ASD
Vineland Adaptive Behavior Scales-Classroom Edition (VABS-Classroom)	Goin-Kochel 2007[427]	USA	Longitudinal observational	To assess the developmental trajectories of children with autism enrolled in ABA-based school
Vineland Adaptive Behavior Scales (VABS)	Aldred 2004[318]	England	Intervention RCT	'Social communication intervention targeting parental communication'
	Anan 2008[396]	USA	Other – quantitative case series	To examine the efficacy of the GIFT programme, a 12-week (180 hours, delivered 3 hours each weekday) parent-training for preschoolers with ASDs
	Andersson 2013[409]	Sweden	Longitudinal observational	To explore gender-related differences in ASD characteristics
	Arick 2003[388]	USA	Cross-sectional observational	To track programme implementation variables and outcome data for students with ASDs engaged in school or home programmes
	Baghdadli 2012[339]	France	Longitudinal observational	Developmental trajectory of adaptive behaviours
	Bearss 2013[278]	USA	Longitudinal observational	To assess the feasibility and efficacy of a parent training programme
	Ben Itzchak 2011[320]	Israel	Intervention quasi-experimental	The study explored child and parental characteristics at baseline that may predict outcomes in adaptive skills and acquisition of cognitive gains
	Bennett 2008[296]	Canada	Longitudinal observational	To explore 'specific language impairment' as a predictor of children's symptom and functional outcome
	Carlsson 2013[390]	Sweden	Cross-sectional observational	To analyse co-occurring disorders and problems in a representative group of 198 preschool children with ASD
	Cassidy 2008[348]	Northern Ireland	Cross-sectional observational	To describe the demographic characteristics of preschoolers and their families; to discover parental perceptions of the child's difficulties; to identify the impact the child has on family life; to outline the supports available to families and those they would like to have
	Dawson 2010[321]	USA	Intervention RCT	Efficacy of the ESDM, a comprehensive developmental behavioural intervention, for improving outcomes in ASD toddlers

Daily living skills	Paper	Location	Study design	Study aim
	Eapen 2013[357]	Australia	Longitudinal observational	Evaluation of ESDM for preschool-aged children with ASD
	Eikeseth 2009[410]	UK	Longitudinal observational	Effect of intensity of supervision on outcomes
	Eldevik 2012[414]	UK (Wales)	Longitudinal observational	Behavioural intervention outcome for children who had autism
	Eriksson 2013[415]	Sweden	Longitudinal observational	To explore frequency of other medical conditions in autism
	Gabriels 2007[416]	USA	Longitudinal observational	To assess the stability of adaptive functioning in two cognitive ability groups of children with an ASD
	Green 2010[253]	UK	Intervention RCT	Early interventions for social communication
	Grindle 2012[417]	UK (Wales)	Intervention quasi-experimental	ABA classroom: educational intervention in a mainstream school setting
	Hedvall 2013[418]	Sweden	Cross-sectional observational	Processing speed and adaptive function
	Herring 2006[411]	Australia	Longitudinal observational	To explore the impact of developmental disorders on children and their families
	Honey 2008[307]	UK	Longitudinal observational	The study tests the following specific hypotheses: 1. Repetitive behaviour items from the ADI-R will group into four factors as identified in ICD-10 2. Children with better ability will have fewer repetitive behaviours than those children with lesser ability 3. Children with better ability will demonstrate a different pattern of repetitive behaviours from children with lesser ability 4. Repetitive behaviours will increase over time in children with ASD
	Hudry 2010[233]	UK	Cross-sectional observational	Recruited as part of Preschool Autism Communication Trial but this report is on baseline data for only receptive vs. expressive skills
	Jasmin 2009[384]	Canada	Cross-sectional observational	To determine the impact of sensory–motor DLS on the performance of DLS in preschool children with ASD
	Jonsdottir 2007[341]	Iceland	Longitudinal observational	The purpose of the present study was to describe stability and change of preschool children in Iceland and to contribute to the accumulation of data on outcome in autism

Daily living skills	Paper	Location	Study design	Study aim
	Klintwall 2012[419]	Sweden	Longitudinal observational	Number and controllability of reinforces as predictors of outcomes for autistic children receiving early and intense behavioural intervention
	Landa 2012[224]	USA	Intervention quasi-experimental	Comprehensive early intervention
	Lerna 2012[325]	Italy	Intervention RCT	PECS vs. CLT
	Lloyd 2013[400]	USA	Cross-sectional observational	Gross and fine motor skills of young children with ASD
	Luyster 2008[129]	USA	Cross-sectional observational	To systematically investigate language in toddlers with ASD and to identify early correlates of receptive and expressive language in this population
	Magiati 2007[308]	UK	Longitudinal observational	To provide data on long-term outcome for children with ASD who have received intensive, comprehensive interventions in their preschool years
	Magiati 2011[309]	UK	Longitudinal observational	To provide data on long-term outcome for children with ASD who have received intensive, comprehensive interventions in their preschool years
	Mayo 2013[310]	USA	Other – retrospective observational	This study examined the relationship between age of language acquisition and later functioning in children with ASD
	McConkey 2010[349]	–	Intervention quasi-experimental	Evaluate a home-based intervention for preschool children with a confirmed diagnosis of ASD
	Munson 2006[420]	USA	Longitudinal observational	The relationship between amygdalar volume at age 3–4 years and outcomes at age 6 years
	Munson 2008[312]	USA	Cross-sectional observational	Latent class analysis of IQ in ASD
	O'Donnell 2012[386]	USA	Cross-sectional observational	To explore sensory processing characteristics in preschool-age children with ASDs
	Osborne 2008[350]	UK	Intervention quasi-experimental	There was great heterogeneity among the interventions delivered and so for analysis interventions were categorised into high vs. low intensity
	Osborne 2009[351]	UK	Longitudinal observational	Evaluate relationship between child behaviour problems and parental stress
	Peters-Scheffer 2010[421]	The Netherlands	Intervention quasi-experimental	Behavioural treatment in preschool

Daily living skills	Paper	Location	Study design	Study aim
	Poon 2012[401]	USA	Longitudinal observational	'The current study uses retrospective video analysis (RVA) methods to investigate the longitudinal trajectories of social-communicative behaviours, as well as their associations with later developmental outcomes'
	Pry 2005[314]	France, Switzerland, Belgium and Luxembourg	Cross-sectional observational	The relationship between expressive language level and psychological development in children with autism 5 years of age
	Ray-Subramanian 2011[327]	USA	Cross-sectional observational	'Their study examined adaptive behaviour and cognitive skills for 125 toddlers on the autism spectrum using the recently updated Vineland-II and Bayley-III'
	Reed 2007[352]	UK	Longitudinal observational	Comparing high- and low-intensity interventions (with comparison of three different types of high-intensity interventions)
	Reed 2007[353]	UK	Longitudinal observational	Compare effectiveness of ABA, special nursery placements and portage; addressing limitations of previous studies by using the same measures at baseline and end point
	Reed 2012[354]	UK	Intervention quasi-experimental	To explore and document the relationships between severity of autism, temporal input of the programme, and the outcome effectiveness for a variety of early interventions for children on the autism spectrum. In particular, ABA, special nursery placement, an adaptation of a portage approach for individuals on the autism spectrum and an eclectic approach developed by a local authority were chosen for study
	Remington 2007[358]	UK	Intervention quasi-experimental	Comparison of early intensive behavioural interventions and treatment as usual
	Restall 1994[422]	Canada	Cross-sectional observational	How does the play of children with autism differ that of normally developing children? What are the relationships between performance and adaptive abilities?
	Rickards 2009[423]	Australia	Intervention RCT	Does home-based programme provided over 12 months result in sustained improvement in development and behaviour?
	Roberts 2011[405]	Australia	Intervention RCT	Comparison of home-based vs. centre-based early intervention programmes

Daily living skills	Paper	Location	Study design	Study aim
	Rogers 2012[317]	USA	Intervention RCT	This study was carried out to examine the efficacy of a 12-week, low-intensity (1 hour per week of therapist contact), parent-delivered intervention for toddlers at risk for ASDs aged 14–24 months and their families
	Ruble 2008[424]	USA	Cross-sectional observational	Effect of caregiver responsiveness on child cognitive and social interactions
	Salt 2002[372]	UK	Intervention quasi-experimental	Developmentally based early intervention programme
	Schertz 2013[402]	USA	Intervention RCT	The purpose of this study was to determine effects of the JAML intervention on acquisition of joint attention and other early social communication competencies for toddlers with ASDs
	Silva 2007[299]	USA	Intervention RCT	Effectiveness of qigong massage methodology, in treating sensory impairment in young children with autism
	Silva 2008[300]	USA	Intervention RCT	Outcomes of pilot of qigong sensory training programme
	Smith 2000[413]	USA	Intervention RCT	Comparing intensive treatment group to parent training group
	Smith 2010[359]	Canada and USA	Intervention quasi-experimental	Effect of a parent training and naturalistic one-to-one behaviour intervention using PRT on language, behaviour and ASD symptoms
	Stahmer 2004[355]	USA	Intervention quasi-experimental	To analyse the outcomes for 20 young children with ASD in an inclusive programme for children aged < 3 years
	Stone 1999[346]	USA	Cross-sectional observational	Patterns of adaptive behaviour in young children with ASD
	Strauss 2012[329]	Italy	Intervention quasi-experimental	Influence of parent inclusion in treatment provision on child's progress
	Szatmari 2000[302]	Canada	Longitudinal observational	Monitoring cognitive and language outcomes of groups of children with autism and Asperger syndrome
	Tonge 2012[425]	Australia	Longitudinal observational	To determine the impact of a PEBM on the mental health and adjustment of parents with preschool children with autism
	Toth 2006[284]	USA	Longitudinal observational	This study investigated the unique contributions of joint attention, imitation, and toy play to language ability and rate of development of communication skills in young children with ASD

Daily living skills	Paper	Location	Study design	Study aim
	VanMeter 1997[426]	USA	Cross-sectional observational	Social, communication and DLS was examined for autistic children, compared with retarded and normal controls
	Ventola 2007[332]	USA	Cross-sectional observational	Behavioural presentation of AD, developmental delay and developmental language disorder
	Werner 2005[316]	USA	Cross-sectional observational	Describing variations in early course of development
	Zachor 2010[335]	Israel	Longitudinal observational	To examine the effect of the intervention approach (ABA, eclectic) on outcome in cognitive, language, and adaptive skills and on changes in autism diagnosis categories
Video coding of feeding behaviour[a]	Brisson 2012[449]	France and Belgium	Cross-sectional observational	Motor anticipation failure in feeding situations

ABA, applied behavioural analysis; CLT, Conventional Language Therapy; DLS, daily living skills; ESDM, Early Start Denver Model; GIFT, Group Intensive Family Training; JAML, Joint Attention Mediated Learning; PEBM, parent education and behaviour management intervention; PECS, Picture Exchange Communication System; PRT, Pivotal Response Treatment; RCT, randomised controlled trial.
a Observational coding.

Global measure of function	Paper	Location	Study design	Study aim
Ages and Stages Questionnaire (ASQ)	Feldman 2012[104]	Canada	Longitudinal observational	Development and evaluation of a new instrument – POEMS
Assessment of Basic Language and Learning Skills (ABLLS)	Goin-Kochel 2007[427]	USA	Longitudinal observational	To assess the developmental trajectories of children with autism enrolled in ABA-based school
	Grindle 2012[417]	UK (Wales)	Intervention quasi-experimental	ABA classroom: educational intervention in a mainstream school setting
	Gupta 2009[303]	India	Cross-sectional observational	To understudy the development of language and learning skills in children with autism and compare with that of typically developing children
Assessment, Evaluation and Programming System (AEPS)	Schwartz 2004[450]	USA	Longitudinal observational	Effect of Project DATA school programme
Behaviour Assessment System for Children-Second Edition (BASC-2)	Hill-Chapman 2013[434]	USA	Cross-sectional observational	Parenting stress
Brigance Diagnostic Inventory of Early Development	Travers 2011[438]	USA	Cross-sectional observational	Comparing teacher- and computer-led instruction on literacy skills development
Developmental Profile	Malhi 2011[342]	India	Longitudinal observational	To assess diagnostic stability of autism diagnosis in children aged ≤ 3 years
Early Development Interview	Werner 2005[316]	USA	Cross-sectional observational	Describing variations in early course of development
Early Intervention Developmental Profile (EIDP)	Jocelyn 1998[298]	Canada	Intervention RCT	Caregiver-based intervention programme in community day care centres
Early Learning Accomplishment Profile (E-LAP)	Virues-Ortega 2013[451]	Spain	Longitudinal observational	This article describes growth patterns of motor, cognitive, verbal, DLS and social skills in a sample of children with ASD admitted into a home-based IBI programme managed by trained behaviour analysts and delivering 20–40 weekly hours of intervention
Functional and Emotional Developmental Questionnaire	Pajareya 2012[343]	Thailand	Intervention quasi-experimental	Determine the results of 1-year DIR/Floortime parent training in developmental stimulation of children with ASD
	Pajareya 2011[344]	Thailand	Intervention RCT	RCT of DIR/Floortime intervention for autistic children
Learning Accomplishment Profile-Diagnostic, Third Edition, (LAP-D)	Virues-Ortega 2013[451]	Spain	Longitudinal observational	This article describes growth patterns of motor, cognitive, verbal, DLS and social skills in a sample of children with ASD admitted into a home-based IBI programme managed by trained behaviour analysts and delivering 20–40 weekly hours of intervention

Global measure of function	Paper	Location	Study design	Study aim
Paediatric Daily Occupation Scale	Hsieh 2013[452]	Taiwan	Cross-sectional observational	Well-being of mothers of children with ASD in Taiwan
Preschool Developmental Profile (PSDP)	Jocelyn 1998[298]	Canada	Intervention RCT	Caregiver-based intervention programme in community day care centres
Psychoeducational Profile-Revised (PEP-R)	Delmolino 2006[432]	USA	Longitudinal observational	To assess if scores obtained by the PEP-R are reasonable estimates of cognitive ability, correlating with scores from another instrument (Stanford–Binet Intelligence Scales, 4th edn)
	Herring 2006[411]	Australia	Longitudinal observational	To explore the impact of developmental disorders on children and their families
	McConkey 2010[349]	–	Intervention quasi-experimental	Evaluate a home-based intervention for preschool children with a confirmed diagnosis of ASD
	Osborne 2008[350]	UK	Intervention quasi-experimental	There was great heterogeneity among the interventions delivered and so for analysis interventions were categorised into high vs. low intensity
	Ozonoff 1998[453]	USA	Intervention quasi-experimental	Evaluate the effectiveness of a TEACCH-based home programme intervention
	Reed 2007[352]	UK	Longitudinal observational	Comparing high- and low-intensity interventions (with comparison of three different types of high-intensity interventions)
	Reed 2007[353]	UK	Longitudinal observational	Compare effectiveness of ABA, special nursery placements and portage; addressing limitations of previous studies by using the same measures at baseline and end point
	Reed 2012[354]	UK	Intervention quasi-experimental	To explore and document the relationships between severity of autism, temporal input of the programme, and the outcome effectiveness for a variety of early interventions for children on the autism spectrum. In particular, ABA, special nursery placement, an adaptation of a portage approach for individuals on the autism spectrum, and an eclectic approach developed by a local authority were chosen for study
	Tonge 2012[425]	Australia	Longitudinal observational	To determine the impact of a PEBM on the mental health and adjustment of parents with preschool children with autism

Global measure of function	Paper	Location	Study design	Study aim
Scales of Independent Behavior Revised-early development form (SIB-R)	Keen 2010[363]	Australia	Intervention quasi-experimental	To reduce parenting stress and increase parenting competence for families of children within 6 months of receiving an ASD diagnosis
Vineland Adaptive Behavior Scales-Classroom Edition (VABS-Classroom)	Goin-Kochel 2007[427]	USA	Longitudinal observational	To assess the developmental trajectories of children with autism enrolled in ABA-based school
Vineland Adaptive Behavior Scales (VABS)	Aldred 2004[318]	England	Intervention RCT	'Social communication intervention targeting parental communication'
	Anan 2008[396]	USA	Other – quantitative case series	To examine the efficacy of the GIFT programme, a 12-week (180 hours, delivered 3 hours each weekday) parent-training for preschoolers with ASDs
	Andersson 2013[409]	Sweden	Longitudinal observational	To explore gender-related differences in ASD characteristics
	Arick 2003[388]	USA	Cross-sectional observational	To track programme implementation variables and outcome data for students with ASDs engaged in school or home programmes
	Baghdadli 2012[339]	France	Longitudinal observational	Developmental trajectory of adaptive behaviours
	Bearss 2013[278]	USA	Longitudinal observational	To assess the feasibility and efficacy of a parent training programme
	Ben Itzchak 2011[320]	Israel	Intervention quasi-experimental	The study explored child and parental characteristics at baseline that may predict outcomes in adaptive skills and acquisition of cognitive gains
	Bennett 2008[296]	Canada	Longitudinal observational	To explore 'specific language impairment' as a predictor of children's symptom and functional outcome
	Carlsson 2013[390]	Sweden	Cross-sectional observational	To analyse co-occurring disorders and problems in a representative group of 198 preschool children with ASD
	Cassidy 2008[348]	Northern Ireland	Cross-sectional observational	To: • describe the demographic characteristics of preschoolers and their families • discover parental perceptions of the child's difficulties • identify the impact the child has on family life • outline the supports available to families and those they would like to have

Global measure of function	Paper	Location	Study design	Study aim
	Dawson 2010[321]	USA	Intervention RCT	Efficacy of the ESDM, a comprehensive developmental behavioural intervention, for improving outcomes in ASD toddlers
	Eapen 2013[357]	Australia	Longitudinal observational	Evaluation of ESDM for preschool-aged children with ASD
	Eikeseth 2009[410]	UK	Longitudinal observational	Effect of intensity of supervision on outcomes
	Eldevik 2012[414]	UK (Wales)	Longitudinal observational	Behavioural intervention outcome for children who had autism
	Eriksson 2013[415]	Sweden	Longitudinal observational	To explore frequency of other medical conditions in autism
	Gabriels 2007[416]	USA	Longitudinal observational	To assess the stability of adaptive functioning in two cognitive ability groups of children with an ASD
	Green 2010[253]	UK	Intervention RCT	Early interventions for social communication
	Grindle 2012[417]	UK (Wales)	Intervention quasi-experimental	ABA classroom: educational intervention in a mainstream school setting
	Hedvall 2013[418]	Sweden	Cross-sectional observational	Processing speed and adaptive function
	Herring 2006[411]	Australia	Longitudinal observational	To explore the impact of developmental disorders on children and their families
	Honey 2008[307]	UK	Longitudinal observational	The study tests the following specific hypotheses: 1. Repetitive behaviour items from the ADI-R will group into four factors as identified in ICD-10 2. Children with better ability will have fewer repetitive behaviours than those children with lesser ability 3. Children with better ability will demonstrate a different pattern of repetitive behaviours from children with lesser ability 4. Repetitive behaviours will increase over time in children with ASD
	Hudry 2010[233]	UK	Cross-sectional observational	Recruited as part of Preschool Autism Communication Trial but this report is on baseline data for only receptive vs. expressive skills
	Jasmin 2009[384]	Canada	Cross-sectional observational	To determine the impact of sensory–motor DLS on the performance of DLS in preschool children with ASD

Global measure of function	Paper	Location	Study design	Study aim
	Jonsdottir 2007[341]	Iceland	Longitudinal observational	The purpose of the present study was to describe stability and change of preschool children in Iceland and to contribute to the accumulation of data on outcome in autism
	Klintwall 2012[419]	Sweden	Longitudinal observational	Number and controllability of reinforces as predictors of outcomes for autistic children receiving early and intense behavioural intervention
	Landa 2012[224]	USA	Intervention quasi-experimental	Comprehensive early intervention
	Lerna 2012[325]	Italy	Intervention RCT	PECS vs. CLT
	Lloyd 2013[400]	USA	Cross-sectional observational	Gross and fine motor skills of young children with ASD
	Luyster 2008[129]	USA	Cross-sectional observational	To systematically investigate language in toddlers with ASD and to identify early correlates of receptive and expressive language in this population
	Magiati 2007[308]	UK	Longitudinal observational	To provide data on long-term outcome for children with ASD who have received intensive, comprehensive interventions in their preschool years
	Magiati 2011[309]	UK	Longitudinal observational	To provide data on long-term outcome for children with ASD who have received intensive, comprehensive interventions in their preschool years
	Mayo 2013[310]	USA	Other – retrospective observational	This study examined the relationship between age of language acquisition and later functioning in children with ASD
	McConkey 2010[349]	–	Intervention quasi-experimental	Evaluate a home-based intervention for preschool children with a confirmed diagnosis of ASD
	Munson 2006[420]	USA	Longitudinal observational	The relationship between amygdalar volume at age 3–4 years and outcomes at age 6 years
	Munson 2008[312]	USA	Cross-sectional observational	Latent class analysis of IQ in ASD
	O'Donnell 2012[386]	USA	Cross-sectional observational	To explore sensory processing characteristics in preschool-age children with ASDs
	Osborne 2008[350]	UK	Intervention quasi-experimental	There was great heterogeneity among the interventions delivered and so for analysis interventions were categorised into high vs. low intensity

Global measure of function	Paper	Location	Study design	Study aim
	Osborne 2009[351]	UK	Longitudinal observational	Evaluate relationship between child behaviour problems and parental stress
	Peters-Scheffer 2010[421]	The Netherlands	Intervention quasi-experimental	Behavioural treatment in preschool
	Poon 2012[401]	USA	Longitudinal observational	'The current study uses retrospective video analysis (RVA) methods to investigate the longitudinal trajectories of social-communicative behaviours, as well as their associations with later developmental outcomes'
	Pry 2005[314]	France, Switzerland, Belgium and Luxembourg	Cross-sectional observational	The relationship between expressive language level and psychological development in children with autism 5 years of age
	Ray-Subramanian 2011[327]	USA	Cross-sectional observational	'Their study examined adaptive behaviour and cognitive skills for 125 toddlers on the autism spectrum using the recently updated Vineland-II and Bayley-III'
	Reed 2007[352]	UK	Longitudinal observational	Comparing high- and low-intensity interventions (with comparison of three different types of high-intensity interventions)
	Reed 2007[353]	UK	Longitudinal observational	Compare effectiveness of ABA, special nursery placements and portage; addressing limitations of previous studies by using the same measures at baseline and end point
	Reed 2012[354]	UK	Intervention quasi-experimental	To explore and document the relationships between severity of autism, temporal input of the programme, and the outcome effectiveness for a variety of early interventions for children on the autism spectrum. In particular, ABA, special nursery placement, an adaptation of a portage approach for individuals on the autism spectrum, and an eclectic approach developed by a local authority were chosen for study
	Remington 2007[358]	UK	Intervention quasi-experimental	Comparison of early intensive behavioural interventions and treatment as usual
	Restall 1994[422]	Canada	Cross-sectional observational	How does the play of children with autism differ that of normally developing children? What are the relationships between performance and adaptive abilities?

Global measure of function	Paper	Location	Study design	Study aim
	Rickards 2009[423]	Australia	Intervention RCT	Does home-based programme provided over 12 months result in sustained improvement in development and behaviour?
	Roberts 2011[405]	Australia	Intervention RCT	Comparison of home-based vs. centre-based early intervention programmes
	Rogers 2012[317]	USA	Intervention RCT	This study was carried out to examine the efficacy of a 12-week, low-intensity (1 hour per week of therapist contact), parent-delivered intervention for toddlers at risk for ASDs aged 14–24 months and their families
	Ruble 2008[424]	USA	Cross-sectional observational	Effect of caregiver responsiveness on child cognitive and social interactions
	Salt 2002[372]	UK	Intervention quasi-experimental	Developmentally based early intervention programme
	Schertz 2013[402]	USA	Intervention RCT	The purpose of this study was to determine effects of the JAML intervention on acquisition of joint attention and other early social communication competencies for toddlers with ASDs
	Silva 2007[299]	USA	Intervention RCT	Effectiveness of qigong massage methodology, in treating sensory impairment in young children with autism
	Silva 2008[300]	USA	Intervention RCT	Outcomes of pilot of qigong sensory training programme
	Smith 2000[413]	USA	Intervention RCT	Comparing intensive treatment group to parent training group
	Smith 2010[359]	Canada and USA	Intervention quasi-experimental	Effect of a parent training and naturalistic one-to-one behaviour intervention using PRT on language, behaviour and ASD symptoms
	Stahmer 2004[355]	USA	Intervention quasi-experimental	To analyse the outcomes for 20 young children with ASD in an inclusive programme for children aged < 3 years
	Stone 1999[346]	USA	Cross-sectional observational	Patterns of adaptive behaviour in young children with ASD
	Strauss 2012[329]	Italy	Intervention quasi-experimental	Influence of parent inclusion in treatment provision on child's progress
	Szatmari 2000[302]	Canada	Longitudinal observational	Monitoring cognitive and language outcomes of groups of children with autism and Asperger syndrome

Global measure of function	Paper	Location	Study design	Study aim
	Tonge 2012[425]	Australia	Longitudinal observational	To determine the impact of a PEBM on the mental health and adjustment of parents with preschool children with autism
	Toth 2006[284]	USA	Longitudinal observational	This study investigated the unique contributions of joint attention, imitation, and toy play to language ability and rate of development of communication skills in young children with ASD
	VanMeter 1997[426]	USA	Cross-sectional observational	Social, communication and DLS was examined for autistic children, compared with retarded and normal controls
	Ventola 2007[332]	USA	Cross-sectional observational	Behavioural presentation of AD, developmental delay and developmental language disorder
	Werner 2005[316]	USA	Cross-sectional observational	Describing variations in early course of development
	Zachor 2010[335]	Israel	Longitudinal observational	To examine the effect of the intervention approach (ABA, eclectic) on outcome in cognitive, language, and adaptive skills and on changes in autism diagnosis categories
Social Adaptive Development Quotient Scale (ADQ)[a]	Zhang 2012[303]	China	Intervention quasi-experimental	TEAS was applied to children with autism to assess its therapeutic efficacy

ABA, applied behavioural analysis; AD, autistic disorder; CLT, Conventional Language Therapy; DIR, Developmental, Individual-Difference, Relationship-Based; DLS; daily living skills; ESDM, Early Start Denver Model; GIFT, Group Intensive Family Training; IBI, intensive behavioural intervention; JAML, Joint Attention Mediated Learning; PEBM, parent education and behavioural management intervention; PECS, Picture Exchange Communication System; PRT, Pivotal Response Treatment; RCT, randomised controlled trial; TEACCH, Treatment and Education of Autistic and Related Handicapped Children; TEAS, transcutaneous electrical acupoint stimulation.
a Non-UK.

Global measure of outcome	Paper	Location	Study design	Study aim
Autism Treatment Evaluation Checklist (ATEC)	Goin-Kochel 2007[427]	USA	Longitudinal observational	To assess the developmental trajectories of children with autism enrolled in ABA-based school
Behavioral Summarized Evaluation Scale-Revised (BSE-R)	Receveur 2005[337]	France	Longitudinal observational	Interaction and imitation deficits from infancy to 4 years of age in children with autism
	Maestro 2005[338]	Italy	Cross-sectional observational	Providing new criteria to describe the early course of ASD
Clinical Global Impression – Improvement Scale	Bearss 2013[278]	USA	Longitudinal observational	To assess the feasibility and efficacy of a parent training programme
	Oosterling 2010[326]	The Netherlands	Intervention RCT	Intervention is 'Focus parent training'. Home-based parent training promoting compliance, mutual enjoyment, joint attention and language development
Infant Behavioral Summarized Evaluation (IBSE)	Adrien 1992[90]	France	Longitudinal observational	To observe and analyse the evolution of behavioural pathology in autistic children
	Receveur 2005[337]	France	Longitudinal observational	Interaction and imitation deficits from infancy to 4 years of age in children with autism
Pervasive Developmental Disorders Behavior Inventory (PDDBI)	Silva 2009[226]	USA	Intervention RCT	Improvement following a qigong massage intervention
	Silva 2011[301]	USA	Intervention RCT	Dual parent and trainer-delivered qigong massage intervention for measures of autism, abnormal sensory responses and self-regulation

ABA, applied behavioural analysis; RCT,randomised controlled trial.

Subjective well-being	Paper	Location	Study design	Study aim
Kiddie-Infant Descriptive Instrument for Emotional States (KIDIES)[a]	Trad 1993[454]	USA	Cross-sectional observational	To determine whether the KIDIES tool could detect individual differences in responsivity among the PDD subjects, 'to ascertain the KIDIES' sensitivity in identifying group differences between PDD subjects and control children with other developmental disorders

a Pre-1995.

Social inclusion	Paper	Location	Study design	Study aim
School Liking and Avoidance Questionnaire	Jahromi 2013[431]	USA	Longitudinal observational	The importance of self-regulation for the school and peer engagement of children with high-functioning autism
Teacher Rating Scale of School Adjustment	Jahromi 2013[431]	USA	Longitudinal observational	The importance of self-regulation for the school and peer engagement of children with high-functioning autism

Interaction style	Paper	Location	Study design	Study aim
Functional Emotional Assessment Scale	Pajareya 2012[343]	Thailand	Intervention quasi-experimental	Determine the results of 1-year DIR/Floortime parent training in developmental stimulation of children with ASD
	Pajareya 2011[344]	Thailand	Intervention RCT	RCT of DIR/Floortime intervention for autistic children
NICHD Early Child Care Network scales	Baker 2010[397]	USA	Longitudinal observational	'Examined parent behaviour during unstructured play sessions with high- and low-risk toddlers who did or did not receive later ASD diagnoses, and investigated associations with concurrent child behaviour problems and later language growth'
Coded observation of social behaviour[a]	Meirsschaut 2011[442]	Belgium	Cross-sectional observational	Assessment of ASD vs. TD mother–child dyads and mothers–unfamiliar child dyad interactions
Coding of videos[a]	Flippin 2011[406]	USA	Longitudinal observational	To investigate the concurrent relationships between the verbal and play responsiveness of 16 mothers and fathers and the object play skills of 16 children with ASDs
Parental skills – video ratings[a]	Oosterling 2010[326]	The Netherlands	Intervention RCT	Intervention is 'Focus parent training'. Home-based parent training promoting compliance, mutual enjoyment, joint attention and language development
Parent–child free play[a]	Freeman 2013[443]	USA	Cross-sectional observational	Parent–child play
Parent–child interaction[a]	Green 2010[253]	UK	Intervention RCT	Early interventions for social communication
Parent–Child Interaction measure[a]	Aldred 2012[319]	UK	Other – a RCT	A mediation analysis aimed at assessing the impact of targeted intervention on autism characteristics
Preschool teacher–child play[a]	Kaale 2012[294]	Norway	Intervention RCT	To explore effectiveness of parent-mediated and specialist-mediated joint attention-intervention
Social Interaction Rating Scale[a]	Ruble 2008[424]	USA	Cross-sectional observational	Effect of caregiver responsiveness on child cognitive and social interactions

DIR, Developmental, Individual-Difference, Relationship-Based; RCT, randomised controlled trial; TD, typically developing.
a Observational coding.

Parent stress	Paper	Location	Study design	Study aim
Autism Parenting Stress Index (APSI)	Silva 2011[301]	USA	Intervention RCT	Dual parent and trainer-delivered qigong massage intervention for measures of autism, abnormal sensory responses and self-regulation
Beck Anxiety Inventory	Davis 2008[455]	USA	Longitudinal observational	To explore the associations between child behaviour and parenting stress
Center for Epidemiologic Studies Depression Inventory	Davis 2008[455]	USA	Longitudinal observational	To explore the associations between child behaviour and parenting stress
	Taylor 2012[436]	USA	Longitudinal observational	To examine the reported symptoms and correlates of depression in caregivers of young children following ASD diagnosis
General Health Questionnaire (GHQ)	Herring 2006[411]	Australia	Longitudinal observational	To explore the impact of developmental disorders on children and their families
	McConkey 2010[349]	–	Intervention quasi-experimental	Evaluate a home-based intervention for preschool children with a confirmed diagnosis of ASD
	Tonge 2005[456]	Australia	Intervention RCT	To determine the impact of a PEBM on the mental health and adjustment of parents with preschool children with autism
Hospital Anxiety and Depression Scale (HADS)	Remington 2007[358]	UK	Intervention quasi-experimental	Comparison of early intensive behavioural interventions and treatment as usual
Parenting Stress Index-Short Form (PSI-SF)	Strauss 2012[329]	Italy	Intervention quasi-experimental	Influence of parent inclusion in treatment provision on child's progress
Parenting Sense of Competence (PSOC)	Keen 2007[364]	Australia	Longitudinal observational	To investigate the effects of the Stronger Families Project on communication and symbolic behaviour of young children with autism and to explore possible correlations between post-intervention changes in children's communication and symbolic behaviour, and child adaptive behaviour, chronological age, maternal stress and sense of parenting competence
	Keen 2010[363]	Australia	Intervention quasi-experimental	To reduce parenting stress and increase parenting competence for families of children within 6 months of receiving an ASD diagnosis
Parenting Stress Index (PSI)	Aldred 2004[318]	England	Intervention RCT	'Social communication intervention targeting parental communication'
	Baker-Ericzen 2005[457]	USA	Intervention quasi-experimental	Examine parental stress before and after involvement in an inclusive toddler programme
	Keen 2010[363]	Australia	Intervention quasi-experimental	To reduce parenting stress and increase parenting competence for families of children within 6 months of receiving an ASD diagnosis

Parent stress	Paper	Location	Study design	Study aim
	Roberts 2011[405]	Australia	Intervention RCT	Comparison of home-based vs. centre-based early intervention programmes
	Salt 2002[372]	UK	Intervention quasi-experimental	Developmentally based early intervention programme
Parenting Stress Index-Short Form (PSI-SF)	Bendixen 2011[458]	USA	Intervention quasi-experimental	To explore parental differences pre–post an interdisciplinary in-home training programme
	Davis 2008[455]	USA	Longitudinal observational	To explore the associations between child behaviour and parenting stress
	Hill-Chapman 2013[434]	USA	Cross-sectional observational	Parenting stress
	Minjarez 2013[459]	USA	Intervention quasi-experimental	To evaluate whether participating in a PRT group therapy programme for parents of children with autism influenced related aspects of parents' lives, namely, their levels of stress and empowerment
	Wang 2013[460]	China	Cross-sectional observational	The aim of the current study was to further the knowledge about stress experienced by Chinese mothers of children with ASD by examining maternal parenting stress in Heilongjiang province of China
	Wong 2010[333]	China	Intervention RCT	To pilot a 2-week 'Autism 1-2-3' early intervention for children with autism and their parents immediately after diagnosis that targeted at (1) eye contact, (2) gesture and (3) vocalisation/words
Positive and Negative Affect Scale (PANAS)	Hsieh 2013[452]	Taiwan	Cross-sectional observational	Well-being of mothers of children with ASD in Taiwan
Questionnaire on Resources and Stress	Cassidy 2008[348]	Northern Ireland	Cross-sectional observational	To describe the demographic characteristics of preschoolers and their families; to discover parental perceptions of the child's difficulties; to identify the impact the child has on family life; to outline the supports available to families and those they would like to have
	McConkey 2010[349]	–	Intervention quasi-experimental	Evaluate a home-based intervention for preschool children with a confirmed diagnosis of ASD
	Osborne 2008[350]	UK	Intervention quasi-experimental	There was great heterogeneity among the interventions delivered and so for analysis interventions were categorised into high vs. low intensity
	Osborne 2009[351]	UK	Longitudinal observational	Evaluate relationship between child behaviour problems and parental stress
	Remington 2007[358]	UK	Intervention quasi-experimental	Comparison of early intensive behavioural interventions and treatment as usual

Parent stress	Paper	Location	Study design	Study aim
	Rickards 2009[423]	Australia	Intervention RCT	Does home-based programme provided over 12 months resulted in sustained improvement in development and behaviour?
Questionnaire on Resources and Stress-Short Form	Reed 2013[437]	UK	Cross-sectional observational	The study assessed whether teacher and parent ratings of child behaviour problems were similar for children with ASDs
Reaction to Diagnosis Interview	Oppenheim 2012[461]	Israel	Cross-sectional observational	This study examined the hypothesis that maternal sensitivity mediates the association between maternal insightfulness/resolution and child attachment in a sample of preschool age boys with ASDs
	Wachtel 2008[462]	USA	Longitudinal observational	Examined the relationship between a mother's acceptance of and sense of resolution regarding her child's diagnosis of an ASD and maternal interaction style, controlling for child competence, autism symptoms and maternal depression
Satisfaction with Life Scale	Hsieh 2013[452]	Taiwan	Cross-sectional observational	Well-being of mothers of children with ASD in Taiwan
Stress Arousal Checklist	Jocelyn 1998[298]	Canada	Intervention RCT	Caregiver-based intervention programme in community day care centres
Symptom Checklist-90-Revised (SCL-90)	Bennett 2012[304]	Canada	Longitudinal observational	Impact of maternal depression on mother's reports of her child's ASD behaviours
Daily occupational experience[a]	Hsieh 2013[452]	Taiwan	Cross-sectional observational	Well-being of mothers of children with ASD in Taiwan
Parent–Child Interaction Rating Scales[a]	Wachtel 2008[462]	USA	Longitudinal observational	Examined the relationship between a mother's acceptance of and sense of resolution regarding her child's diagnosis of an ASD and maternal interaction style, controlling for child competence, autism symptoms and maternal depression
Parenting stress thermometer[a]	Tonge 2005[456]	Australia	Intervention RCT	To determine the impact of a PEBM on the mental health and adjustment of parents with preschool children with autism
Self-constructed questionnaire[a]	Farmer 2013[463]	Australia	Longitudinal observational	To parent's knowledge and understanding of autism, improve their confidence in managing their child and decrease parental anxiety
Stress thermometer[a]	Herring 2006[411]	Australia	Longitudinal observational	To explore the impact of developmental disorders on children and their families

PEBM, parent education and behaviour management intervention; PRT, Pivotal Response Treatment; RCT, randomised controlled trial.
a Tools developed ad hoc.

Family quality of life	Paper	Location	Study design	Study aim
Beach Family Quality of Life Questionnaire	Roberts 2011[405]	Australia	Intervention RCT	Comparison of home-based vs. centre-based early intervention programmes
Family Adaptability and Cohesion Evaluation Scales	Bendixen 2011[458]	USA	Intervention quasi-experimental	To explore parental differences pre–post an interdisciplinary in-home training programme
Family Assessment Device	Herring 2006[411]	Australia	Longitudinal observational	To explore the impact of developmental disorders on children and their families
	Tonge 2005[456]	Australia	Intervention RCT	To determine the impact of a PEBM on the mental health and adjustment of parents with preschool children with autism
Family Assessment Measure	Jocelyn 1998[298]	Canada	Intervention RCT	Caregiver-based intervention programme in community day care centres
Family Empowerment Scale	Minjarez 2013[459]	USA	Intervention quasi-experimental	To evaluate whether participating in a PRT group therapy programme for parents of children with autism influenced related aspects of parents' lives, namely, their levels of stress and empowerment
	Rickards 2009[423]	Australia	Intervention RCT	Does home-based programme provided over 12 months result in sustained improvement in development and behaviour?
Family Support Scale	Rickards 2009[423]	Australia	Intervention RCT	Does home-based programme provided over 12 months result in sustained improvement in development and behaviour?
Kansas Inventory of Parental Perceptions	Remington 2007[358]	UK	Intervention quasi-experimental	Comparison of early intensive behavioural interventions and treatment as usual
Parenting Alliance Inventory	Hill-Chapman 2013[434]	USA	Cross-sectional observational	Parenting stress
Familial Resources Index[a]	Baghdadli 2012[339]	France	Longitudinal observational	Developmental trajectory of adaptive behaviours
TRE-ADD Autism Quiz (TAQ)[a]	Jocelyn 1998[298]	Canada	Intervention RCT	Caregiver-based intervention programme in community day care centres
Family Satisfaction Questionnaire[a]	Smith 2000[413]	USA	Intervention RCT	Comparing intensive treatment group to parent training group

PEBM, parent education and behaviour management intervention; PRT, Pivotal Response Treatment; RCT, randomised controlled trial.
a Tools developed ad hoc.

Chapter 3 Tools used (participant description)

Symptom severity	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
Autism Behavior Checklist (AuBC)	Bennett 2008[296]	Children aged between 4 and 6 years	64	64	100	–	–	4–6	Years	57	7	Asperger syndrome, high-functioning autism
	Gupta 2009[303]	Children had a mean age of 4.8 years at start of the study and were diagnosed of autism based on DSM-IV-TR criteria	40	20	50	4.16	0.86	–	Years	12	8	Autism
	Jocelyn 1998[298]	24- to 72-month-old children who met DSM III-R criteria	35	35	100	43.2	9.1	–	Months	27	8	Autism, PDD-NOS
	Silva 2007[299]	3–6 years old with DSM-IV diagnosis of ASD	15	15	100	4.83	–	3–6	Years	13	2	AD
	Silva 2008[300]	3–6 years old with DSM-IV diagnosis of ASD	26	26	100	56.3	12.5	–	Months	21	5	Autism
	Silva 2009[226]	3–6 years old with DSM-IV diagnosis of ASD	46	46	100	59.2	–	–	Months	37	9	Autism
	Silva 2011[301]	3–6 years old with clinical diagnosis of ASD	47	47	100	4.83	–	3–6	Years	33	14	Autism
	Szatmari 2000[302]	4–6 years old (upon entering study) diagnosed by ADI	134	68	51	66.8	–	–	Months	59	7	Autism, Asperger syndrome
	Zhang 2012[303]	76 children with ASD (mean age 4.09, SD 1.66)	96	96	100	4.37	1.6	–	Years	68	8	Autistic
Autism Diagnostic Interview-Revised (ADI-R)	Bennett 2012[304]	Children with ASD aged 2–4 years old	214	178	83	–	–	2–4	Years	181	33	AD, Asperger syndrome, PDD-NOS
	Ben Itzchak 2008[149]	Children aged 19–35 months with autism diagnosis based on DSM-IV criteria	81	44	54	–	–	16–35	Months	43	1	Autism
	Brian 2008[305]	Children had no diagnosis of ASD but were followed up to 36 months at which point some were diagnosed with ASD	228	35	15	–	–	6–12	Months	NR	NR	Autism, Asperger syndrome, PDD-NOS

Symptom severity	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
	Feldman 2012[104]	Children who aged between 1 and 24 months who were 'at risk' for autism (they had a sibling with a diagnosis of ASD, Asperger syndrome or PDD-NOS)	108 (parents)	108	100	8	5	–	Months	74	34	AD, PDD-NOS, Asperger syndrome and high-functioning autism
	Hambly 2012[306]	Children with ASDs from bilingual and monolingual homes	75	75	100	–	–	36–78	Months	60	15	Autism, ASD, Asperger syndrome, PDD-NOS
	Honey 2008[307]	24–48 months diagnosed by ICD-10 criteria	104	79	76	37.05	6.08	24–48	Months	65	14	ASD
	Magiati 2007[308]	Children aged between 22 and 54 months who met Autism Diagnostic Interview-Revised criteria for autism/ASD diagnosis	44	44	100	–	–	22–54	Months	39	5	Autism, ASD
	Magiati 2011[309]	Mean age of 3.4 years at start of the study	44	44	100	38.9	7.1	27–55	Months	39	5	Autism, ASD
	Mayo 2013[310]	45–72 months with DSM-IV-TR criteria	119	119	100	52.22	6.09	45–72	Months	99	20	AD, PDD-NOS
	Mooney 2006[311]	22–51 months with DSM-IV diagnosis of ASD	55	40	73	36.95	7.26	22–51	Months	34	6	AD
	Munson 2008[312]	24–66 months with ADI or ADOS diagnosis of ASD	456	456	100	43.4	8.7	24–66	Months	370	86	Autism, ASD
	Ozonoff 2010[313]	Assessed between 6 and 36 months, diagnosed using ADOS	50	25	50	–	–	6	Months	19	6	AD, PDD-NOS
	Pry 2005[314]	21 months to 7 years with ICD-10 diagnosis of ASD	222	222	100	5	1.75	1.75–7	Years	180	42	Infantile autism
	Richler 2007[315]	Up to 3 years old, with 'clinical' diagnosis of ASD	279	192	69	–	–	0–37	Months	162	30	Autism, PDD-NOS
	Werner 2005[316]	12–57 months with DSM-IV diagnosis of ASD	145	72	50	43.5	4.3	–	Months	60	12	AD, PDD-NOS

Symptom severity	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
Autism Diagnostic Observation Scale-Toddler Module (ADOS-T)	Rogers 2012[317]	14–24 months with ASD	98	98	100	21	–	–	Months	76	22	ASD
Autism Diagnostic Observation Schedule (ADOS)	Aldred 2004[318]	2 years to 5 years 11 months with ADI diagnosis	28	28	100	–	–	24–71	Months	25	3	AD or 'classical autism'
	Aldred 2012[319]	Children aged 2–5 years assessed using ADOS and ADI-R	28	28	100	–	–	2–5	Years	25	3	Autism
	Ben Itzchak 2008[149]	Children aged 19–35 months with autism diagnosis based on DSM-IV criteria	81	44	54	–	–	16–35	Months	43	1	Autism
	Ben Itzchak 2011[320]	Children aged 15–35 months were included in the study	78	78	100	–	–	15–35	Months	71	7	Autism
	Bennett 2012[304]	Children with ASD aged 2–4 years old	214	178	83	–	–	2–4	Years	181	33	AD, Asperger syndrome, PDD-NOS
	Brian 2008[305]	Children had no diagnosis of ASD but were followed up to 36 months at which point some were diagnosed of ASD	228	35	15	–	–	6–12	Months	NR	NR	Autism, Asperger syndrome, PDD-NOS
	Dawson 2010[321]	18–30 months, diagnosed by ADOS, ADI and DSM-IV	48	48	100	–	–	18–30	Months	37	11	AD, PDD-NOS
	Gotham 2012[322]	Best-estimate clinical diagnosis of ASD at one or more time points	345	345	100	3.3	1.4	–	Years	282	63	Autism, PDD-NOS
	Green 2010[253]	24–60 months, ADOS or ADI diagnosed	152	152	100	45	–	24–60	Months	138	14	Core autism
	Hartley 2009[323]	Children aged 1.5–3.9 years based on DSM-IV-TR criteria and ADOS-G classification	499	199	40	–	–	18–47	Months	157	42	AD, PDD-NOS
	Landa 2012[224]	22-to 33-month-old children with ASD or autism	48	48	100	27	2.8	22–33	Months	39	9	ASD
	Lerna 2012[325]	18–60 months old with diagnosis of autism and little or no functional language	18	18	100	–	–	18–60	Months	17	1	Autism

Symptom severity	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
	Luyster 2008[129]	Participants were aged 18–33 months and met ADI-R criteria for ASD diagnosis	164	164	100	–	–	18–33	Months	129	35	ASD
	Munson 2008[312]	24–66 months with ADI or ADOS diagnosis of ASD	456	456	100	43.4	8.7	24–66	Months	370	86	Autism, ASD
	Oosterling 2010[326]	12–42 months old with 'clinical' diagnosis of ASD	80	80	100	34.8	–	–	Months	62	18	Autism, PDD-NOS
	Ray-Subramanian 2011[327]	23–39 months with DSM-IV or ICD-10 diagnosis of ASD	125	125	100	31	4.1	23–39	Months	108	17	Autism, AD, PDD-NOS
	Ray-Subramanian 2012[328]	2–3 years with DSM-IV diagnosis	115	115	100	31	4.1	–	Months	97	18	Autism, AD, PDD-NOS
	Strauss 2012[329]	26–81 months with DSM-IV diagnosis of ASD	44	44	100	–	–	26–81	Months	41	3	Autism, PDD-NOS
	Sullivan 2007[330]	Tested at 14–24 months and 30–36 months, and who met DSM-IV criteria for diagnosis	51	16	31	–	–	14–36	Months	14	2	Autism, PDD-NOS
	Tek 2012[331]	16–38 months with ADOS diagnosis	84	84	100	27	–	16–38	Months	NR	NR	ASD
	Ventola 2007[332]	16–32 months old with M-CHAT diagnosis of ASD	195	195	100	–	–	16–32	Months	152	43	ASD
	Werner 2005[316]	12–57 months with DSM-IV diagnosis of ASD	145	72	50	43.5	4.3	–	Months	60	12	AD, PDD-NOS
	Wong 2010[333]	17–36 months children diagnosed by DSM-IV, ADI and ADOS	17	17	100	–	–	17–36	Months	16	1	–
	Zachor 2006[334]	Participants were aged 23–33 months and met DSM-IV criteria for autism diagnosis	39	39	100	–	–	23–33	Months	37	2	Autism
	Zachor 2010[335]	15- to 35-month-old children who met DSM-IV criteria	71	71	100	25.55	4.25	15–35	Months	71	7	Autism

Symptom severity	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
Autism Observation Scale for Infants (AOSI)	Brian 2008[305]	Children had no diagnosis of ASD but were followed up to 36 months at which point some were diagnosed of ASD	228	35	15	–	–	6–12	Months	NR	NR	Autism, Asperger syndrome, PDD-NOS
	Bryson 2008[81]	Infant siblings of children with ASD or autism	34	34	100	6.7	–	6.1–18.9	Months	19	15	Autism, ASD, Asperger syndrome, PDD-NOS
Baby and Infant Screen for Children with aUtIsm Traits (BISCUIT-Part 1)	Fodstad 2009[342]	Children were aged 17–37 months and met the criteria for ASD or PDD-NOS based on DSMI-V-TR	886	886	100	26.53	5.02	17–37	Months	618	268	Autism, PDD-NOS
Behavioral Summarized Evaluation Scale-Revised (BSE-R)	Receveur 2005[337]	Observed from 10 months old to 4 years old – met DSM-IV criteria for ASD	18	18	100	58	3.2	10–59	Months	13	5	AD
Behavioral Summarized Evaluation (BSE)	Maestro 2005[338]	Videos of first year of life observed, all met DSM-IV criteria for ASD	40	40	100	–	–	0–1	Years	32	8	AD, PDD-NOS
Childhood Autism Rating Scale (CARS)	Baghdadli 2012[339]	Age < 7 years, ICD-10 diagnosis of autism	280	280	100	4.9	1.3	–	Months	230	50	Childhood autism, atypical autism
	Bopp 2009[340]	Children were aged 1–6 years at start of the study	69	69	100	–	–	1–6	Years	58	11	Autism, PDD-NOS
	Jonsdottir 2007[341]	Mean age was 41.43 months; diagnosis was based on ICD-10 criteria	41	41	100	41.43	9.06	22–59	Months	34	7	Childhood autism
	Malhi 2011[342]	Children were ≤ 3 years at start of the study and had an ASD diagnosis based on DSM-IV criteria	77	77	100	–	–	0–3	Years	64	13	AD, PDD-NOS
	Mayo 2013[310]	45–72 months with DSM-IV-TR criteria	119	119	100	52.22	6.09	45–72	Months	99	20	AD, PDD-NOS
	Pajareya 2012[343]	2–6 years old with ASD	34	34	100	4.23	1.16	2–6	Years	30	4	Autism, PDD-NOS
	Pajareya 2011[344]	24–72 months old with DSM-IV diagnosis for ASD	32	32	100	54.05	–	24–72	Months	28	4	Autism, PDD-NOS

Symptom severity	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
	Papavasiliou 2011[350]	3–5 years (at start of study) with DSM-IV diagnosis of ASD	40	40	100	3.9	–	3–5	Years	36	4	ASD
	Pry 2005[314]	21 months to 7 years with ICD-10 diagnosis of ASD	222	222	100	5	1.75	1.75–7	Years	180	42	Infantile autism
	Stone 1999[346]	Children who met DSM-IV criteria for autism and were aged 31.4 months (SD = 3.4 months) at start of the study	37	37	100	31.4	3.4	–	Months	29	8	Autism, PDD-NOS
	Ventola 2007[332]	16–32 months old with M-CHAT diagnosis of ASD	195	195	100	–	–	16–32	Months	152	43	ASD
	Vorgraft 2007[347]	38–49 month old children with DSM-IV diagnosis of PDD-NOS	23	23	100	42.8	–	38–49	Months	15	8	Autism, PDD-NOS
	Zhang 2012[303]	76 children with ASD (mean age 4.09, SD 1.66)	96	96	100	4.37	1.6	–	Years	68	8	Autistic
Gilliam Autism Rating Scale (GARS)	Cassidy 2008[348]	Parents of children aged < 5 years with ICD-10 diagnosis of ASD	104	104	100	–	–	2–4	Years	95	9	ASD
	McConkey 2010[349]	Children with ASD diagnosis (criteria not given, it was only stated as 'confirmed diagnosis of ASD from a specialist clinic') who had a mean age of 2.8 years at start of the study	62 (families)	61	98	–	–	< 4	Years	55	6	Autism
	Osborne 2008[350]	2.6–4 years old with GARS diagnosis of ASD	65	65	100	–	–	2.6–4.0	Years	59	6	ASD
	Osborne 2009[351]	2.6–4 years old with GARS diagnosis of ASD	65	65	100	3.4	0.75	2.6–4.0	Years	59	6	ASD
	Reed 2007[352]	2 years 6 months to 4 years old diagnosed with ASD	27	27	100	–	–	2.5–4.0	Years	27	0	ASD

Symptom severity	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
	Reed 2007[353]	2 years 6 months to 4 years old with 'paediatrician' diagnosis of ASD	53	53	100	–	–	2.5–4.0	Years	Unclear	Unclear	ASD
	Reed 2012[354]	2.5–4 years with GARS diagnosis of ASD	66	66	100	40.2	5.6	–	Months	59	7	AD, PDD-NOS
	Stahmer 2004[355]	0–3 years with DSM-IV diagnosis	20	20	100	28.6	–	22–32	Months	16	4	AD, PDD-NOS
Infant Behavioral Summarized Evaluation (IBSE)	Adrien 1992[90]	0–2 years, DSM-III-R criteria	24	12	50	–	–	0–2	Years	10	2	Autism
	Receveur 2005[337]	Observed from 10 months old to 4 years old – met DSM-IV criteria for ASD	18	18	100	58	3.2	10–59	Months	13	5	AD
Modified Checklist for Autism in Toddlers (M-CHAT)	Ventola 2007[332]	16–32 months old with M-CHAT diagnosis of ASD	195	195	100	–	–	16–32	Months	152	43	ASD
Parent Observation of Early Markers Scale (POEMS)	Feldman 2012[104]	Children who aged between 1 and 24 months who were 'at risk' for autism (they had a sibling with a diagnosis of ASD, Asperger syndrome or PDD-NOS)	108 (parents)	108	100	8	5	–	Months	74	34	AD, PDD-NOS, Asperger syndrome and high-functioning autism
Pervasive Developmental Disorder Rating Scale (PDDRS)	Eaves 2006[356]	Details of how diagnosis was made not stated. Children were aged 1–6 years	199	199	100	–	–	1.8–3.9	Years	157	42	AD
Pervasive Developmental Disorders Behavior Inventory (PDDBI)	Silva 2009[226]	3–6 years with DSM-IV diagnosis of ASD	46	46	100	59.2	–	–	Months	37	9	Autism
	Silva 2011[301]	3–6 years old with clinical diagnosis of ASD	47	47	100	4.83	–	3–6	Years	33	14	Autism
Real Life Rating Scale (Ritvo–Freeman) (RLRS)	Wong 2010[333]	17–36 months children diagnosed by DSM-IV, ADI and ADOS	17	17	100	–	–	17–36	Months	16	1	–

Symptom severity	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
Social Communication Questionnaire (SCQ)	Eapen 2013[357]	Mean age of 49.6 months	26	26	100	49.6	6.08	36–58	Months	21	5	AD
	Remington 2007[358]	30–42 months of age with ADI diagnosis of ASD	44	44	100	37	4.2	30–42	Months	NR	NR	Autism or suspected autism
Social Responsiveness Scale (SRS)	Bennett 2012[304]	Children with ASD aged 2–4 years old	214	178	83	–	–	2–4	Years	181	33	AD, Asperger syndrome, PDD-NOS
	Hambly 2012[306]	Children with ASDs from bilingual and monolingual homes	75	75	100	–	–	36–78	Months	60	15	Autism, ASD, Asperger syndrome, PDD-NOS
	Smith 2010[359]	All < 6 years with ADOS/ADI/DSM-IV diagnosis of ASD	53	53	100	50.1	10	–	Months	47	6	Autism
Childhood Autism Rating Scale (CARS) – Tokyo version[a]	Takeda 2005[360]	23–35 months with DSM-IV criteria	57	57	100	31.4	3.3	23–35	Months	45	12	AD, PDD-NOS, Asperger

AD, autistic disorder; DSM-IV-TR, *Diagnostic and Statistical Manual of Mental Disorders*-Fourth Edition-Text Revision; F, female; M, male; NR, not reported; SD, standard deviation.
a Non-UK.

Social awareness	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
Child Behaviour Rating Scale (CBRS) (Modified)	Casenhiser 2013[361]	Children aged 2–4 years 11 months who met ADI-R criteria	51	51	100	–	–	2.0–4.9	Years	NR	NR	ASD
Communication and Symbolic Behavior Scales-Developmental Profile (CSBS–DP)	Green 2010[253]	24–60 months, ADOS or ADI diagnosed	152	152	100	45	–	24–60	Months	138	14	Core autism
	Landa 2007[368]	Assessed between 14–36 months of age, 30/107 sibling subsequently diagnosed with ASD using DSM-IV criteria	125	30	24	–	–	6–36	Months	30	25	Autism, PDD-NOS
	Sullivan 2007[330]	Tested at 14–24 months and 30–36 months who met DSM-IV criteria for diagnosis	51	16	31	–	–	14–36	Months	14	2	Autism, PDD-NOS
	Keen 2010[363]	Children aged 2–4 years who met the DSM-IV criteria for ASD diagnosis	39	39	100	–	–	2–4	Years	34	5	ASD
	Keen 2007[364]	Diagnosis of autism was based on DSM-IV criteria	16	16	100	–	–	2–4	Years	14	2	Autism
Early Social Communication Scale (ESCS)	Dereu 2012[365]	Children aged 2–4 years; ADOS was used for diagnosis	17	9	53	–	–	17–39	Months	6	3	ASD
	Goods 2013[366]	36- to 60-month-old children with autism (ADOS assessment)	15	15	100	51.9	–	–	Months	NR	NR	Autism
	Ingersoll 2012[286]	27 children between 27 and 47 months old who met DSM-IV-TR criteria	29	29	100	37.9	–	22–47	Months	24	5	AD
	Kaale 2012[294]	Children aged 29–60 months who had a diagnosis of autistic disorder based on ICD-10 criteria	61	61	100	–	–	24–60	Months	48	13	Autism
	Kalas 2012[367]	4- to 6-year-old children with ASD	30	30	100	–	–	4–6	Years	28	2	ASD
	Kasari 2006[368]	Children were aged 3–4 years and had a diagnosis of autism based on ADI-R and ADOS criteria	58	58	100	–	–	3–4	Years	46	12	Autism

Social awareness	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
	Lawton 2012[369]	Preschool age children who had a diagnosis of autism, validated by ADI-R	52	52	100	43.05	6.86	–	Months	40	12	Autism
	Luyster 2008[129]	Participants were aged 18–33 months and met ADI-R criteria for ASD diagnosis	164	164	100	–	–	18–33	Months	129	35	ASD
	Paparella 2011[370]	20–72 months old with ADI diagnosis of ASD	83	50	60	53.6	–	36–72	Months	42	8	Autism
	Remington 2007[358]	30–42 months of age with ADI diagnosis of ASD	44	44	100	37	4.2	30–42	Months	NR	NR	Autism or suspected autism
	Roos 2008[371]	30–38 months with ADOS diagnosis of ASD	20	20	100	33.2	–	30–38	Months	16	4	ASD
	Salt 2002[372]	Preschool children in Scotland, (mean 42.36 months) with ICD-10 diagnosis of ASD	17	17	100	40.015	–	–	Months	14	3	Childhood autism
	Wong 2013[373]	3–6 years with CARS diagnosis	33	33	100	56.79	–	–	Months	29	4	Autism
	Yoder 2006[374]	1.9–4.5 years with ADOS diagnosis of ASD	36	36	100	2.9	–	–	Years	31	5	Autism, PDD-NOS
Early Social Communication Scales (ESCS)-Abridged	Yoder 2010[375]	18–60 months with ADOS diagnosis of ASD	36	36	100	2.9	–	–	Years	NR	NR	Autism, PDD-NOS
Imitation Battery (IB)	Luyster 2008[129]	Participants were aged 18–33 months and met ADI-R criteria for ASD diagnosis	164	164	100	–	–	18–33	Months	129	35	ASD
Imitation Disorders Evaluation (IDE) scale	Receveur 2005[337]	Observed from 10 months old to 4 years old – met DSM-IV criteria for ASD	18	18	100	58	3.2	10–59	Months	13	5	AD
Motor Imitation Scale (MIS)	Ingersoll 2010[376]	Participants were aged 27–47 months and met DSM-IV-TR criteria for autism diagnosis	22	22	100	–	–	27–47	Months	19	3	Autism

Social awareness	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
	Ingersoll 2012[286]	27 children between 27 and 47 months old who met DSM-IV-TR criteria	29	29	100	37.9	–	22–47	Months	24	5	AD
Preschool Imitation and Praxis Scale (PIPS)	Dereu 2012[365]	Children aged 2–4 years; ADOS was used for diagnosis	17	9	53	–	–	17–39	Months	6	3	ASD
Pre-Verbal Communication Schedule (PVCS)	Salt 2002[372]	Preschool children in Scotland, (mean 42.36 months) with ICD-10 diagnosis of ASD	17	17	100	40.015	–	–	Months	14	3	Childhood autism
Social Communication Assessment for Toddlers with Autism (SCATA)	Drew 2007[137]	Children aged between 21–43 months with a diagnosis of autism or PDD based on ICD-10 criteria	46	46	100	25	5.6, NR	18–44, NR	Months	39	7	Autism, PDD-NOS
Social Communication Behavior Codes	Ozonoff 2010[313]	Assessed between 6 and 36 months, diagnosed using ADOS	50	25	50	–	–	6	Months	19	6	AD, PDD-NOS
Parent interview[a]	Clifford 2008[377]	3–5 years with DSM-IV criteria	63	36	57	51.05	–	–	Months	33	3	AD
Caregiver–child interaction[b]	Kasari 2006[368]	Children were aged 3–4 years and had a diagnosis of autism based on ADI-R and ADOS criteria	58	58	100	–	–	3–4	Years	46	12	Autism
Coded observation of joint attention[b]	Warreyn 2007[384]	1.83–5.5 years with DSM-IV diagnosis of ASD	36	18	50	4.01	0.86	2.17–5.5	Years	15	3	AD, PDD-NOS
Coding of initiation of joint attention[b]	Ingersoll 2012[286]	27 children between 27 and 47 months old who met DSM-IV-TR criteria	29	29	100	37.9	–	22–47	Months	24	5	AD
Classroom Observation Measure[b]	Goods 2013[366]	36- to 60-month-old children with autism (ADOS assessment)	15	15	100	51.9	–	–	Months	NR	NR	Autism
Examiner Ratings of Social Engagement[b]	Ozonoff 2010[313]	Assessed between 6 and 36 months, diagnosed using ADOS	50	25	50	–	–	6	Months	19	6	AD, PDD-NOS

Social awareness	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
Naturalistic examiner–child play sample[b]	Roos 2008[371]	30–38 months with ADOS diagnosis of ASD	20	20	100	33.2	–	30–38	Months	16	4	ASD
Pre-linguistic Communication Assessment[b]	Stone 1997[135]	25–39 months with DSM-III or DSM-IV diagnosis of ASD	28	14	50	32.8	3.5	27–38	Months	NR	NR	Autism
Preschool teacher–child play[b]	Kaale 2012[294]	Children aged 29–60 months who had a diagnosis of autistic disorder based on ICD-10 criteria	61	61	100	–	–	24–60	Months	48	13	Autism
Unstructured free play with examiner[b]	Lerna 2012[325]	18–60 months old with diagnosis of autism and little or no functional language	18	18	100	–	–	18–60	Months	17	1	Autism
Unstructured Imitation Assessment[b]	Ingersoll 2012[286]	27 children between 27 and 47 months old who met DSM-IV-TR criteria	29	29	100	37.9	–	22–47	Months	24	5	AD
	Ingersoll 2010[376]	Participants were aged 27–47 months and met DSM-IV-TR criteria for autism diagnosis	22	22	100	–	–	27–47	Months	19	3	Autism
Video coding procedures[b]	Colgan 2006[379]	Children aged 8–12 months with diagnosis of autism based on DSM-III-R or DSM-IV criteria	35	21	60	–	–	0–2	Years	17	4	AD
Video observation[b]	Clifford 2008[377]	3–5 years with DSM-IV criteria	63	36	57	51.05	–	–	Months	33	3	AD
Video rating for expressive speech[b]	Baghdadli 2012[339]	Age < 7 years, ICD-10 diagnosis of autism	280	280	100	4.9	1.3	–	Months	230	50	Childhood autism, atypical autism
Video recording of child in classroom activities[b]	Ingersoll 2001[380]	Children ages 26–41 months who met DSM-IV criteria for ASD	9	6	67	–	–	26–41	Months	NR	NR	Autism, PDD-NOS

AD, autistic disorder; DSM-IV-TR, *Diagnostic and Statistical Manual of Mental Disorders*-Fourth Edition-Text Revision; F, female; M, male; NR, not reported; SD, standard deviation.
a Tools developed ad hoc.
b Observational coding.

Restricted, repetitive behaviour	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
Autism Diagnostic Interview (ADI)	Ben Itzchak 2008[149]	Children aged 19–35 months with autism diagnosis based on DSM-IV criteria	81	44	54	–	–	16–35	Months	43	1	Autism
Autism Diagnostic Interview-Revised (ADI-R)	Bennett 2012[304]	Children with ASD aged 2–4 years old	214	178	83	–	–	2–4	Years	181	33	AD, Asperger syndrome, PDD-NOS
	Brian 2008[305]	Children had no diagnosis of ASD but were followed up to 36 months at which point some were diagnosed of ASD	228	35	15	–	–	6–12	Months	NR	NR	Autism, Asperger syndrome, PDD-NOS
	Feldman 2012[104]	Children who aged between 1 and 24 months who were 'at risk' for autism (they had a sibling with a diagnosis of ASD, Asperger syndrome or PDD-NOS)	108 (parents)	108	100	8	5	–	Months	74	34	AD, PDD-NOS, Asperger syndrome and high-functioning autism
Autism Diagnostic Interview-Revised (ADI-R)	Hambly 2012[306]	Children with ASDs from bilingual and monolingual homes	75	75	100	–	–	36–78	Months	60	15	Autism, ASD, Asperger syndrome, PDD-NOS
Autism Diagnostic Interview (ADI)	Honey 2008[307]	24–48 months diagnosed by ICD-10 criteria	104	79	76	37.05	6.08	24–48	Months	65	14	ASD
Autism Diagnostic Interview-Revised (ADI-R)	Magiati 2007[308]	Children aged between 22 and 54 months who met ADI-R criteria for autism/ASD diagnosis	44	44	100	–	–	22–54	Months	39	5	Autism, ASD
	Magiati 2011[309]	Mean age of 3.4 years at start of the study	44	44	100	38.9	7.1	27–55	Months	39	5	Autism, ASD
	Mayo 2013[310]	45–72 months with DSM-IV-TR criteria	119	119	100	52.22	6.09	45–72	Months	99	20	AD, PDD-NOS
	Mooney 2006[311]	22–51 months with DSM-IV diagnosis of ASD	55	40	73	36.95	7.26	22–51	Months	34	6	AD

Restricted, repetitive behaviour	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
	Munson 2008[312]	24–66 months with ADI or ADOS diagnosis of ASD	456	456	100	43.4	8.7	24–66	Months	370	86	Autism, ASD
	Ozonoff 2010[313]	Assessed between 6 and 36 months, diagnosed using ADOS	50	25	50	–	–	6	Months	19	6	AD, PDD-NOS
Autism Diagnostic Interview (ADI)	Pry 2005[314]	21 months to 7 years with ICD-10 diagnosis of ASD	222	222	100	5	1.75	1.75–7	Years	180	42	Infantile autism
ADI-R (ADI-R)	Richler 2007[315]	Up to 3 years old, with 'clinical' diagnosis of ASD	279	192	69	–	–	0–37	Months	162	30	Autism, PDD-NOS
Autism Diagnostic Interview (ADI)	Werner 2005[316]	12–57 months with DSM-IV diagnosis of ASD	145	72	50	43.5	4.3	–	Months	60	12	AD, PDD-NOS
Autism Diagnostic Observation Scale-Toddler Module (ADOS-T)	Rogers 2012[317]	14–24 months with ASD	98	98	100	21	–	–	Months	76	22	ASD
Autism Diagnostic Observation Schedule-Generic (ADOS-G) – Modules 1 and 2)	Green 2010[253]	24–60 months, ADOS or ADI diagnosed	152	152	100	45	–	24–60	Months	138	14	Core autism
	Aldred 2004[318]	2 years to 5 years 11 months with ADI diagnosis	28	28	100	–	–	24–71	Months	25	3	AD or 'classical autism'
	Aldred 2012[319]	Children aged 2–5 years assessed using ADOS and ADI-R	28	28	100	–	–	2–5	Years	25	3	Autism
	Ben Itzchak 2008[149]	Children aged 19–35 months with autism diagnosis based on DSM-IV criteria	81	44	54	–	–	16–35	Months	43	1	Autism
	Ben Itzchak 2011[320]	Children aged 15–35 months were included in the study	78	78	100	–	–	15–35	Months	71	7	Autism
	Bennett 2012[304]	Children with ASD aged 2–4 years old	214	178	83	–	–	2–4	Years	181	33	AD, Asperger syndrome, PDD-NOS

Restricted, repetitive behaviour	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
	Brian 2008[305]	Children had no diagnosis of ASD but were followed up to 36 months at which point some were diagnosed of ASD	228	35	15	–	–	6–12	Months	NR	NR	Autism, Asperger syndrome, PDD-NOS
	Dawson 2010[321]	18–30 months, diagnosed by ADOS, ADI and DSM-IV	48	48	100	–	–	18–30	Months	37	11	AD, PDD-NOS
	Gotham 2012[322]	Best-estimate clinical diagnosis of ASD at one or more time points	345	345	100	3.3	1.4	–	Years	282	63	Autism, PDD-NOS
	Hartley 2009[323]	Children aged 1.5–3.9 years based on DSM-IV-TR criteria and ADOS-G classification	499	199	40	–	–	18–47	Months	157	42	AD, PDD-NOS
	Landa 2012[224]	22- to 33-month-old children with ASD or autism	48	48	100	27	2.8	22–33	Months	39	9	ASD
	Lerna 2012[325]	18–60 months old with diagnosis of autism and little or no functional language	18	18	100	–	–	18–60	Months	17	1	Autism
	Luyster 2008[129]	Participants were aged 18–33 months and met ADI-R criteria for ASD diagnosis	164	164	100	–	–	18–33	Months	129	35	ASD
	Munson 2008[312]	24–66 months with ADI or ADOS diagnosis of ASD	456	456	100	43.4	8.7	24–66	Months	370	86	Autism, ASD
	Oosterling 2010[326]	12–42 months old with 'clinical' diagnosis of ASD	80	80	100	34.8	–	–	Months	62	18	Autism, PDD-NOS
	Ray-Subramanian 2011[327]	23–39 months with DSM-IV or ICD-10 diagnosis of ASD	125	125	100	31	4.1	23–39	Months	108	17	Autism, AD, PDD-NOS
	Ray-Subramanian 2012[328]	2–3 years with DSM-IV diagnosis	115	115	100	31	4.1	–	Months	97	18	Autism, AD, PDD-NOS

Restricted, repetitive behaviour	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
	Strauss 2012[329]	26–81 months with DSM-IV diagnosis of ASD	44	44	100	–	–	26–81	Months	41	3	Autism, PDD-NOS
	Sullivan 2007[330]	Tested at 14–24 months and 30–36 months who met DSM-IV criteria for diagnosis	51	16	31	–	–	14–36	Months	14	2	Autism, PDD-NOS
	Tek 2012[331]	16–38 months with ADOS diagnosis	84	84	100	27	–	16–38	Months	NR	NR	ASD
	Ventola 2007[332]	16–32 months old with M-CHAT diagnosis of ASD	195	195	100	–	–	16–32	Months	152	43	ASD
	Werner 2005[316]	12–57 months with DSM-IV diagnosis of ASD	145	72	50	43.5	4.3	–	Months	60	12	AD, PDD-NOS
	Wong 2010[333]	17–36 months children diagnosed by DSM-IV, ADI and ADOS	17	17	100	–	–	17–36	Months	16	1	–
	Zachor 2006[334]	Participants were aged 23–33 months and met DSM-IV criteria for autism diagnosis	39	39	100	–	–	23–33	Months	37	2	Autism
	Zachor 2010[335]	15- to 35-month-old children who met DSM-IV criteria	71	71	100	25.55	4.25	15–35	Months	71	7	Autism
Repetitive Behavior Scale (RBS)	Dawson 2010[321]	18–30 months, diagnosed by ADOS, ADI and DSM-IV	48	48	100	–	–	18–32	Months	37	11	AD, PDD-NOS
Classroom and playground behaviour observations[a]	Escalona 2001[271]	Children were aged 3–6 years based on DSM III – R	20	20	100	5.2	1.8	3–6	Years	12	8	Autism
Video coding[a]	Barber 2012[381]	18–24 months ASD	100	50	50	–	–	18–24	Months	43	7	AD, PDD-NOS

AD, autistic disorder; DSM-IV-TR, *Diagnostic and Statistical Manual of Mental Disorders*-Fourth Edition-Text Revision; F, female; M, male; NR, not reported; SD, standard deviation.
a Observational coding.

Sensory processing	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
Infant/Toddler Sensory Profile (ITSP)	Ben-Sasson 2008[382]	18–33 months old children, diagnosed by ADOS and ADI	170	170	100	28	4	18–33	Months	133	37	AD, PDD-NOS
Sense and Self-Regulation Checklist (SSC)	Silva 2009[226]	3–6 years with DSM-IV diagnosis of ASD	46	46	100	59.2	–	–	Months	37	9	Autism
Sense and Self-Regulation Checklist (SSC)	Silva 2011[301]	3–6 years old with clinical diagnosis of ASD	47	47	100	4.83	–	3–6	Years	33	14	Autism
Sensory Profile (SP)	Chuang 2012[383]	Children were aged 48–84 months and had DSM-IV-TR diagnosis of autism	111	67	60	–	–	48–84	Months	57	10	Autism
	Jasmin 2009[384]	Children aged 3–4 years who had a diagnosis of ASD based on DSM-IV criteria	35	35	100	–	–	3–4	Years	32	3	Autistic, PDD-NOS, Asperger syndrome
	Provost 2009[385]	3–5 years with DSM-IV criteria of ASD	50	25	50	–	–	3.0–5.9	Years	19	6	AD, PDD-NOS
	Silva 2007[299]	3–6 years old with DSM-IV diagnosis of ASD	15	15	100	4.83	–	3–6	Years	13	2	AD
	Silva 2008[300]	3–6 years old with DSM-IV diagnosis of ASD	26	26	100	56.3	12.5	–	Months	21	5	Autism
Short Sensory Profile (SSP)	O'Donnell 2012[386]	3–4 years old with DSM-IV diagnosis of ASD	42	42	100	45.5	–	36–59	Months	NR	NR	Autism, PDD-NOS
	Papavasiliou 2011[345]	3–5 years (at start of study) with DSM-IV diagnosis of ASD	40	40	100	3.9	–	3–5	Years	36	4	ASD
	Tomchek 2007[387]	3–6 years with DSM-IV criteria for ASD	562	281	50	51.58	10.3	–	Months	235	46	Autism, PDD-NOS, Asperger syndrome

AD, autistic disorder; DSM-IV-TR, *Diagnostic and Statistical Manual of Mental Disorders*-Fourth Edition-Text Revision; F, female; M, male; NR, not reported; SD, standard deviation.

Language	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
Autism Screening Instrument for Educational Planning (ASIEP)	Arick 2003[388]	Children between the ages of 2 and 6 years (at baseline) who have been said to have a diagnosis of autism; details of criteria used not provided	67	67	100	–	–	2–6	Years	NR	NR	ASD
Battelle Developmental Inventory (BDI)	Arick 2003[388]	Children between the ages of 2 and 6 years (at baseline) who have been said to have a diagnosis of autism; details of criteria used not provided	67	67	100	–	–	2–6	Years	NR	NR	ASD
British Picture Vocabulary Scale	Magiati 2007[308]	Children aged between 22 and 54 months who met ADI-R criteria for autism/ASD diagnosis	44	44	100	–	–	22–54	Months	39	5	Autism, ASD
	Magiati 2011[309]	Mean age of 3.4 years at start of the study	44	44	100	38.9	7.1	27–55	Months	39	5	Autism, ASD
Clinical Evaluation of Language Fundamentals-Revised	Bono 2004[389]	31–64 months with DSM-IV diagnosis of ASD	29	29	100	46.68	9.64	31–64	Months	22	7	AD
Communication and Symbolic Behavior Scales-Developmental Profile (CSBS-DP) (Caregiver Questionnaire)	Tek 2012[331]	16–38 months with ADOS diagnosis	84	84	100	27	–	16–38	Months	NR	NR	ASD
Comprehensive Assessment of Spoken Language (CASL)	Casenhiser 2013[361]	Children aged 2–4 years 11 months who met ADI-R criteria	51	51	100	–	–	2.0–4.9	Years	NR	NR	ASD
Expressive One-Word Picture Vocabulary Test	Arick 2003[388]	Children between the ages of 2 and 6 years (at baseline) who have been said to have a diagnosis of autism; details of criteria used not provided	67	67	100	–	–	2–6	Years	NR	NR	ASD
	Bopp 2009[340]	Children were aged 1–6 years at start of the study	69	69	100	–	–	1–6	Years	58	11	Autism, PDD-NOS

Language	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
	Magiati 2007[308]	Children aged between 22 and 54 months who met ADI-R criteria for autism/ASD diagnosis	44	44	100	–	–	22–54	Months	39	5	Autism, ASD
	Magiati 2011[309]	Mean age of 3.4 years at start of the study	44	44	100	38.9	7.1	27–55	Months	39	5	Autism, ASD
Illinois Test of Psycholinguistic Abilities	Carlsson 2013[390]	Children aged from 4.5 to 6.5 years who were assessed to have autism based on DSM-IV criteria	198	119	60	–	–	4.5–6.5	Years	NR	NR	Autistic-like condition, Asperger syndrome, autistic traits
MacArthur–Bates Communicative Development Inventories (MCDI)	Aldred 2004[318]	2 years to 5 years 11 months with ADI diagnosis	28	28	100	–	–	24–71	Months	25	3	AD or 'classical autism'
	Green 2010[253]	24–60 months, ADOS or ADI diagnosed	152	152	100	45	–	24–60	Months	138	14	Core autism
	Hambly 2012[306]	Children with ASDs from bilingual and monolingual homes	75	75	100	–	–	36–78	Months	60	15	Autism, ASD, Asperger syndrome, PDD-NOS
	Hudry 2010[233]	24- to 59-month-old children with ADOS-G diagnosis	152	152	100	44.83	7.98	24–59	Months	138	14	Core autism
	Luyster 2008[129]	Participants were aged 18–33 months and met ADI-R criteria for ASD diagnosis	164	164	100	–	–	18–33	Months	129	35	ASD
	Miniscalco 2012[391]	20–47 months with DSM-IV diagnosis of ASD	31	31	100	36	–	20–47	Months	27	4	Autistic disorder
	Mitchell 2006[392]	'At risk' children with a sibling with 'clinical' diagnosis of ASD – 11–15 months at first assessment	146	15	10	–	–	11–15	Months	10	5	ASD
	Oosterling 2010[326]	12–42 months old with 'clinical' diagnosis of ASD	80	80	100	34.8	–	–	Months	62	18	Autism, PDD-NOS
	Rogers 2012[317]	14–24 months with ASD	98	98	100	21	–	–	Months	76	22	ASD
	Salt 2002[372]	Preschool children in Scotland, (mean 42.36 months) with ICD-10 diagnosis of ASD	17	17	100	40.015	–	–	Months	14	3	Childhood autism

Language	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
	Smith 2007[393]	20–71 months old with DSM-IV diagnosis of ASD	35	35	100	45.59	9.89	20.5–67.6	Months	28	7	Autism
	Smith 2010[359]	All < 6 years with ADOS/ADI/ DSM-IV diagnosis of ASD	53	53	100	50.1	10	–	Months	47	6	Autism
	Stone 2001[394]	Assessed at 2 years and 4 years, met DSM-III or DSM-IV criteria for ASD	35	35	100	57.9	4.5	50–67	Months	28	8	Autism, PDD-NOS
	Strauss 2012[329]	26–81 months with DSM-IV diagnosis of ASD	44	44	100	–	–	26–81	Months	41	3	Autism, PDD-NOS
Mullen Scales of Early Learning (MSEL)	Akshoomoff 2006[395]	16–43 months with ADI-R and ADOS diagnosis of ASD	42	22	52	–	–	16–43	Months	17	5	Autism, ASD
	Anan 2008[396]	25- to 68-month-old children who met the diagnosis of ASD based on DSM-IV criteria	72	72	100	–	–	25–68	Months	61	11	AD, PDD-NOS
	Baker 2010[397]	33 'at-risk' children, entered study between ages of 2–18 months, assessed at 18, 24, 30 and 36 months. [24 of the 33 children had a sibling with ASD or PDD (DSM-IV diagnosed)]	33	12	36	18	–	–	Months	NR	NR	ASD
	Barbaro 2012[398]	12- to 22-month children with AD, ASD or DD/language delay	154	125	81	–	–	12–27	Months	100	25	AD, ASD
	Ben Itzchak 2011[320]	Children aged 15–35 months were included in the study	78	78	100	–	–	15–35	Months	71	7	Autism
	Bishop 2011[176]	Children were aged between 2 years and 5 years 11 months	72	53	74	–	–	1–68	Months	44	9	Not given
	Brian 2008[305]	Children had no diagnosis of ASD but were followed up to 36 months at which point some were diagnosed of ASD	228	35	15	–	–	6–12	Months	NR	NR	Autism, Asperger syndrome, PDD-NOS
	Dawson 2010[321]	18–30 months, diagnosed by ADOS, ADI and DSM-IV	48	48	100	–	–	18–31	Months	37	11	AD, PDD-NOS

Language	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
	Dereu 2012[365]	Children aged 2–4 years; ADOS was used for diagnosis	17	9	53	–	–	17–39	Months	6	3	ASD
	Eapen 2013[357]	Mean age of 49.6 months	26	26	100	49.6	6.08	36–58	Months	21	5	AD
	Hartley 2009[323]	Children aged 1.5–3.9 years based on DSM-IV-TR criteria and ADOS-G classification	499	199	40	–	–	18–49	Months	157	42	AD, PDD-NOS
	Honey 2008[307]	24–48 months diagnosed by ICD-10 criteria	104	79	76	37.05	6.08	24–48	Months	65	14	ASD
	Landa 2012[399]	Assessed at aged 6–36 months – 52/197 subsequently diagnosed ASD by ADOS	204	52	25	6	–	–	Months	43	9	ASD
	Landa 2012[224]	22- to 33-month-old children with ASD or autism	48	48	100	27	2.8	22–33	Months	39	9	ASD
	Lloyd 2013[400]	12- to 36-month-old children with ASD	162	162	100	–	–	12–36	Months	140	22	ASD
	Luyster 2008[129]	Participants were aged 18–33 months and met ADI-R criteria for ASD diagnosis	164	164	100	–	–	18–33	Months	129	35	ASD
	Mayo 2013[310]	45–72 months with DSM-IV-TR criteria	119	119	100	52.22	6.09	45–72	Months	99	20	AD, PDD-NOS
	Mitchell 2006[392]	'At risk' children with a sibling with 'clinical' diagnosis of ASD – 11–15 months at first assessment	146	15	10	–	–	11–15	Months	10	5	ASD
	O'Donnell 2012[386]	3–4 years old with DSM-IV diagnosis of ASD	42	42	100	45.5	–	36–59	Months	NR	NR	Autism, PDD-NOS
	Ozonoff 2010[313]	Assessed between 6 and 36 months, diagnosed using ADOS	50	25	50	–	–	6	Months	19	6	AD, PDD-NOS
	Poon 2012[401]	9–12 months (upon entering study) with ADOS, ADI or CARS diagnosis of ASD	29	29	100	4.46	1.49	–	Months	24	5	AD, PDD-NOS, Asperger syndrome

Language	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
	Ray-Subramanian 2012[328]	2–3 years with DSM-IV diagnosis	115	115	100	31	4.1	–	Months	97	18	Autism, AD, PDD-NOS
	Rogers 2012[317]	14–24 months with ASD	98	98	100	21	–	–	Months	76	22	ASD
	Schertz 2013[402]	Mean age 24.6 and 27.5 months with ADOS diagnosis	23	23	100	26.05	–	–	Months	NR	NR	ASD
	Siller 2013[403]	32–82 months with ADI-R and ADOS-G diagnosis	70	70	100	–	–	32–82	Months	64	6	AD
	Sullivan 2007[330]	Tested at 14–24 months and 30–36 months who met DSM-IV criteria for diagnosis	51	16	31	–	–	14–36	Months	14	2	Autism, PDD-NOS
	Tek 2012[331]	16–38 months with ADOS diagnosis	84	84	100	27	–	16–38	Months	NR	NR	ASD
	Thurm 2007[404]	2–3 years and 4–5 years	118	83	70	29.98	4.28	–	Months	71	12	Autism, PDD-NOS
	Toth 2006[284]	34–52 months with ADI-diagnosis of ASD	60	60	100	43.6	4.3	34–52	Months	51	9	AD, PDD-NOS
	Ventola 2007[332]	16–32 months old with M-CHAT diagnosis of ASD	195	195	100	–	–	16–32	Months	152	43	ASD
	Werner 2005[316]	12–57 months with DSM-IV diagnosis of ASD	145	72	50	43.5	4.3	–	Months	60	12	AD, PDD-NOS
	Zachor 2010[335]	15- to 35-month-old children who met DSM-IV criteria	71	71	100	25.55	4.25	15–35	Months	71	7	Autism
Pragmatics Profile	Roberts 2011[405]	2.2–5 years with DSM-IV diagnosis of ASD	95	95	100	–	–	26.3–60.3	Months	86	9	AD, ASD
Preschool Language Scale	Bopp 2009[340]	Children were aged 1–6 years at start of the study	69	69	100	–	–	1–6	Years	58	11	Autism, PDD-NOS
	Casenhiser 2013[361]	Children aged 2–4 years 11 months who met ADI-R criteria	51	51	100	–	–	2.0–4.9	Years	NR	NR	ASD
	Flippin 2011[406]	Children aged 40–69 months with autism diagnosis based on ADOS	16	16	100	53.3	9.6	40–69	Months	12	4	ASD

Language	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
	Green 2010[253]	24–60 months, ADOS or ADI diagnosed	152	152	100	45	–	24–60	Months	138	14	Core autism
	Haebig 2013[407]	24–39 months old children with ASD	40	40	100	31.15	4.37	24–39	Months	33	7	Autism, ASD
	Harris 1991[408]	Preschool children with a diagnosis of autism based on DSM-III and DSM-III-R criteria	46	25	54	53.245	–	40–67	Months	21	4	Autism
	Hudry 2010[233]	24- to 59-month-old children with ADOS-G diagnosis	152	152	100	44.83	7.98	24–59	Months	138	14	Core autism
	Mitchell 2006[392]	'At risk' children with a sibling with 'clinical' diagnosis of ASD – 11–15 months at first assessment	146	15	10	–	–	11–15	Months	10	5	ASD
	Ray-Subramanian 2012[328]	2–3 years with DSM-IV diagnosis	115	115	100	31	4.1	–	Months	97	18	Autism, AD, PDD-NOS
	Smith 2010[359]	All < 6 years with ADOS/ADI/DSM-IV diagnosis of ASD	53	53	100	50.1	10	–	Months	47	6	Autism
	Stone 2001[394]	Assessed at 2 years and 4 years, met DSM-III or DSM-IV criteria for ASD	35	35	100	57.9	4.5	50–67	Months	28	8	Autism, PDD-NOS
Reynell Developmental Language Scales	Andersson 2013[409]	Children aged 1.8–3.9 years who met DSM-IV criteria	40	37	93	–	–	1.8–3.9	Years	18	19	AD, ASD, atypical autism, Asperger syndrome
	Bono 2004[389]	31–64 months with DSM-IV diagnosis of ASD	29	29	100	46.68	9.64	31–64	Months	22	7	AD
	Carlsson 2013[390]	Children aged from 4.5 to 6.5 years who were assessed to have autism based on DSM-IV criteria	198	119	60	–	–	4.5–6.5	Years	NR	NR	Autistic-like condition, Asperger syndrome, autistic traits
	Eikeseth 2009[410]	24–42 months with ICD-10 diagnosis of ASD	23	23	100	34.9	5.7	28–42	Months	17	6	Autism
	Goods 2013[366]	36- to 60-month-old children with autism (ADOS assessment)	15	15	100	51.9	–	–	Months	NR	NR	Autism

Language	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
	Herring 2006[411]	Children were aged between 20 and 51 months who met the DSM-IV criteria for diagnosis	123	84	68	37.75	7.07	–	Months	75	9	AD, PDD-NOS
	Miniscalco 2012[391]	20–47 months with DSM-IV diagnosis of ASD	31	31	100	36	–	20–47	Months	27	4	Autistic disorder
	Remington 2007[358]	30–42 months of age with ADI diagnosis of ASD	44	44	100	37	4.2	30–42	Months	NR	NR	Autism or suspected autism
	Roberts 2011[405]	2.2–5 years with DSM-IV diagnosis of ASD	95	95	100	–	–	26.3–60.3	Months	86	9	AD, ASD
	Sheinkopf 2000[412]	Mean age ranged from 36.09 months (SD = 11.23) to 44.07 months (SD = 8.35) with CARS diagnosis of ASD	26	15	58	36.09	–	–	Months	22	4	Autism
	Smith 2000[413]	18–42 months with 'clinical' diagnosis of ASD	28	28	100	35.92	–	–	Months	23	5	Autism, PDD-NOS
Sequenced Inventory of Communication-Revised	Stone 2001[394]	Assessed at 2 years and 4 years, met DSM-III or DSM-IV criteria for ASD	35	35	100	57.9	4.5	50–67	Months	28	8	Autism, PDD-NOS
Test for Auditory Comprehension of Language	Szatmari 2000[302]	4- to 6-year-old children (upon entering study) diagnosed by ADI	134	68	51	66.8	–	–	Months	59	7	Autism, Asperger syndrome
Test of Language Development	Bennett 2008[296]	Children aged between 4–6 years	64	64	100	–	–	4–6	Years	57	7	Asperger syndrome, high-functioning autism
	Szatmari 2000[302]	4- to 6-year-old children (upon entering study) diagnosed by ADI	134	68	51	66.8	–	–	Months	59	7	Autism, Asperger syndrome
Vineland Adaptive Behavior Scales (VABS)	Aldred 2004[318]	2–5, 11 years with ADI diagnosis	28	28	100	–	–	24–71	Months	25	3	AD or 'classical autism'
	Anan 2008[396]	25- to 68- month-old children who met the diagnosis of ASD based on DSM-IV criteria	72	72	100	–	–	25–68	Months	61	11	AD, PDD-NOS
	Andersson 2013[409]	Children aged 1.8–3.9 years who met DSM-IV criteria	40	37	93	–	–	1.8–3.9	Years	18	19	AD, ASD, atypical autism, Asperger syndrome

Language	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
	Arick 2003[388]	Children between the ages of 2 and 6 years (at baseline) who have been said to have a diagnosis of autism; details of criteria used not provided	67	67	100	–	–	2–6	Years	NR	NR	ASD
	Baghdadli 2012[339]	Age < 7 years, ICD-10 diagnosis of autism	280	280	100	4.9	1.3	–	Months	230	50	Childhood autism, atypical autism
	Bearss 2013[278]	Children were aged between 3 years and 6 years 11 months, and assessed to have autism based on ADOS and clinical observation	16	16	100	–	–	3–6	Years	16	0	AD, PDD-NOS
	Ben Itzchak 2011[320]	Children aged 15–35 months were included in the study	78	78	100	–	–	15–35	Months	71	7	Autism
	Bennett 2008[296]	Children aged between 4 and 6 years	64	64	100	–	–	4–6	Years	57	7	Asperger syndrome, high-functioning autism
	Carlsson 2013[390]	Children aged from 4.5 to 6.5 years who were assessed to have autism based on DSM-IV criteria	198	119	60	–	–	4.5–6.5	Years	NR	NR	Autistic-like condition, Asperger syndrome, autistic traits
	Cassidy 2008[348]	Parents of children aged < 5 years with ICD-10 diagnosis of ASD	104	104	100	–	–	2–4	Years	95	9	ASD
	Dawson 2010[321]	18–30 months, diagnosed by ADOS, ADI and DSM-IV	48	48	100	–	–	18–33	Months	37	11	AD, PDD-NOS
	Eapen 2013[357]	Mean age of 49.6 months	26	26	100	49.6	6.08	36–58	Months	21	5	AD
	Eikeseth 2009[410]	24–42 months with ICD-10 diagnosis of ASD	23	23	100	34.9	5.7	28–42	Months	17	6	Autism
	Eldevik 2012[414]	Children aged 2–6 who had autism diagnosis based on ICD-10 criteria and ADI-R	43	43	100	4.26	1.48	1–6	Years	33	10	Autism, PDD-NOS, Asperger syndrome
	Eriksson 2013[415]	Children aged 20–54 months. Criteria not stated	208	208	100	–	–	20–54	Months	176	32	ASD

Language	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
	Gabriels 2007[416]	Children had a mean age of 31 months and had a clinical diagnosis of autistic disorder or PDD-NOS based on DSM-IV criteria	14	14	100	31	–	–	Months	10	4	AD, PDD-NOS
	Green 2010[253]	24–60 months, ADOS or ADI diagnosed	152	152	100	45	–	24–60	Months	138	14	Core autism
	Grindle 2012[417]	3- to 7-year-old children with autism	29	29	100	–	–	43–72	Months	25	4	Autism
	Hedvall 2013[418]	3.6- to 6.6-year-old children with ASD	190	168	88	55	0.8	42–76	Months	147	21	AD, PDD-NOS, Asperger syndrome
	Herring 2006[411]	Children were aged between 20 and 51 months who met the DSM-IV criteria for diagnosis	123	84	68	37.75	7.07	–	Months	75	9	AD, PDD-NOS
	Honey 2008[307]	24–48 months diagnosed by ICD-10 criteria	104	79	76	37.05	6.08	24–48	Months	65	14	ASD
	Hudry 2010[233]	24- to 59-month-old children with ADOS-G diagnosis	152	152	100	44.83	7.98	24–59	Months	138	14	Core autism
	Jasmin 2009[384]	Children aged 3–4 years who had a diagnosis of ASD based on DSM-IV criteria	35	35	100	–	–	3–4	Years	32	3	Autistic, PDD-NOS, Asperger syndrome
	Jonsdottir 2007[341]	Mean age was 41.43 months; diagnosis was based on ICD-10 criteria	41	41	100	41.43	9.06	22–59	Months	34	7	Childhood autism
	Klintwall 2012[419]	2 years and 3 months to 4 years and 11 months, with clinical diagnosis by paediatrician	21	21	100	3.6	–	2.25–4.9	Years	16	5	Autism
	Landa 2012[224]	22- to 33-month-old children with ASD or autism	48	48	100	27	2.8	22–33	Months	39	9	ASD
	Lerna 2012[325]	18–60 months old with diagnosis of autism and little or no functional language	18	18	100	–	–	18–60	Months	17	1	Autism
	Lloyd 2013[400]	12- to 36-month-old children with ASD	162	162	100	–	–	12–37	Months	140	22	ASD

Language	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
	Luyster 2008[129]	Participants were aged 18–33 months and met ADI-R criteria for ASD diagnosis	164	164	100	–	–	18–33	Months	129	35	ASD
	Magiati 2007[308]	Children aged between 22 and 54 months who met ADI-R criteria for autism/ASD diagnosis	44	44	100	–	–	22–54	Months	39	5	Autism, ASD
	Magiati 2011[309]	Mean age of 3.4 years at start of the study	44	44	100	38.9	7.1	27–55	Months	39	5	Autism, ASD
	Mayo 2013[310]	45–72 months with DSM-IV-TR criteria	119	119	100	52.22	6.09	45–72	Months	99	20	AD, PDD-NOS
	McConkey 2010[349]	Children with ASD diagnosis (criteria not given, it was only stated as 'confirmed diagnosis of ASD from a specialist clinic') who had a mean age of 2.8 years at start of the study	62 (families)	61	98	–	–	< 4	Years	55	6	Autism
	Munson 2006[420]	38–54 months with DSM-IV diagnosis of ASD	45	45	100	47.4	4.2	38–54	Months	38	7	AD, PDD-NOS
	Munson 2008[312]	24–66 months with ADI or ADOS diagnosis of ASD	456	456	100	43.4	8.7	24–66	Months	370	86	Autism, ASD
	O'Donnell 2012[386]	3–4 years old with DSM-IV diagnosis of ASD	42	42	100	45.5	–	36–59	Months	NR	NR	Autism, PDD-NOS
	Osborne 2008[350]	2.6–4 years old with GARS diagnosis of ASD	65	65	100	–	–	2.6–4.0	Years	59	6	ASD
	Osborne 2009[351]	2.6–4 years old with GARS diagnosis of ASD	65	65	100	3.4	0.75	2.6–4.0	Years	59	6	ASD
	Peters-Scheffer 2010[421]	3- to 6-year-old children with DSM-IV diagnosis of AD or PDD-NOS	34	34	100	53.5	5.52	42–62	Months	NR	NR	AD, PDD-NOS
	Poon 2012[401]	9–12 months (upon entering study) with ADOS, ADI or CARS diagnosis of ASD	29	29	100	4.46	1.49	–	Months	24	5	AD, PDD-NOS, Asperger syndrome

Language	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
	Pry 2005[314]	21 months to 7 years with ICD-10 diagnosis of ASD	222	222	100	5	1.75	1.75–7	Years	180	42	Infantile autism
	Ray-Subramanian 2011[327]	23–39 months with DSM-IV or ICD-10 diagnosis of ASD	125	125	100	31	4.1	23–39	Months	108	17	Autism, AD, PDD-NOS
	Reed 2007[352]	2 years 6 months to 4 years old diagnosed with ASD	27	27	100	–	–	2.6–4.0	Years	27	0	ASD
	Reed 2007[353]	2 years 6 months to 4 years old with 'paediatrician' diagnosis of ASD	53	53	100	–	–	2.6–4.0	Years	Unclear	Unclear	ASD
	Reed 2012[354]	2.5–4 years with GARS diagnosis of ASD	66	66	100	40.2	5.6	–	Months	59	7	AD, PDD-NOS
	Remington 2007[358]	30–42 months of age with ADI diagnosis of ASD	44	44	100	37	4.2	30–42	Months	NR	NR	Autism or suspected autism
	Restall 1994[422]	3–6 years with DSM-III diagnosis of ASD	18	9	50	64.76	6.4	–	Months	8	1	Autism
	Rickards 2009[423]	3–5 years, 35/59 diagnosed ASD by DSM-IV criteria	54	54	100	69.65	–	–	Months	43	11	ASD
	Roberts 2011[405]	2.2–5 years with DSM-IV diagnosis of ASD	95	95	100	–	–	26.3–60.3	Months	86	9	AD, ASD
	Rogers 2012[317]	14–24 months with ASD	98	98	100	21	–	–	Months	76	22	ASD
	Ruble 2008[424]	40–71 months with DSM-IV diagnosis of ASD	35	35	100	55.9	–	40.9–70.9	Months	30	5	Autism
	Salt 2002[372]	Preschool children in Scotland, (mean 42.36 months) with ICD-10 diagnosis of ASD	17	17	100	40.015	–	–	Months	14	3	Childhood autism
	Schertz 2013[402]	Mean age 24.6 and 27.5 months with ADOS diagnosis	23	23	100	26.05	–	–	Months	NR	NR	ASD
	Silva 2007[299]	3–6 years old with DSM-IV diagnosis of ASD	15	15	100	4.83	–	3–6	Years	13	2	AD

Language	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
	Silva 2008[300]	3–6 years old with DSM-IV diagnosis of ASD	26	26	100	56.3	12.5	–	Months	21	5	Autism
	Smith 2000[413]	18–42 months with 'clinical' diagnosis of ASD	28	28	100	35.92	–	–	Months	23	5	Autism, PDD-NOS
	Smith 2010[359]	All < 6 years with ADOS/ADI/DSM-IV diagnosis of ASD	53	53	100	50.1	10	–	Months	47	6	Autism
	Stahmer 2004[355]	0–3 years with DSM-IV diagnosis	20	20	100	29.6	–	22–33	Months	16	4	AD, PDD-NOS
	Stone 1999[346]	23–35 months with DSM-III or DSM-IV diagnosis of ASD	60	30	50	31.3	3.3	23–35	Months	25	5	Autism
	Strauss 2012[329]	26–81 months with DSM-IV diagnosis of ASD	44	44	100	–	–	26–81	Months	41	3	Autism, PDD-NOS
	Szatmari 2000[302]	4- to 6-year-old children (upon entering study) diagnosed by ADI	134	68	51	66.8	–	–	Months	59	7	Autism, Asperger syndrome
	Tonge 2012[425]	Children were aged 2.5–5 years and diagnosis was made using a combination of medical reviews, ADI-R and CARS	107	107	100	–	–	2.5–5.0	Years	90	17	AD
	Toth 2006[284]	34–52 months with ADI-diagnosis of ASD	60	60	100	43.6	4.3	34–52	Months	51	9	AD, PDD-NOS
	VanMeter 1997[426]	Mean ages ranged from 2.9 (SD = 0.77) years to 5.7 (SD = 1.31) years meeting DSM-III criteria for ASD	143	57	40	–	–	5.2–6.0	Years	54	3	AD
	Ventola 2007[332]	16–32 months old with M-CHAT diagnosis of ASD	195	195	100	–	–	16–32	Months	152	43	ASD
	Werner 2005[316]	12–57 months with DSM-IV diagnosis of ASD	145	72	50	43.5	4.3	–	Months	60	12	AD, PDD-NOS
	Zachor 2010[335]	15- to 35-month-old children who met DSM-IV criteria	71	71	100	25.55	4.25	15–35	Months	71	7	Autism

Language	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
Vineland Adaptive Behavior Scales-Classroom version (VABS-Classroom)	Goin-Kochel 2007[427]	Children were aged between 29.6–61.4 months; diagnosis was based on ADOS criteria	29	29	100	45.7	9.6	29.6–61.4	Months	27	2	Autism, PDD-NOS
Differential Ability Scales[a]	Bishop 2011[176]	Children were aged between 2 years and 5 years 11 months	72	53	74	–	–	1–68	Months	44	9	Not given
	Ruble 2008[424]	40–71 months with DSM-IV diagnosis of ASD	35	35	100	55.9	–	40.9–70.9	Months	30	5	Autism
	Thurm 2007[404]	2–3 years and 4–5 years	118	83	70	29.98	4.28	–	Months	71	12	Autism, PDD-NOS
Peabody Picture Vocabulary Test[a]	Bopp 2009[340]	Children were aged 1–6 years at start of the study	69	69	100	–	–	1–6	Years	58	11	Autism, PDD-NOS
	Smith 2010[359]	All < 6 years with ADOS/ADI/DSM-IV diagnosis of ASD	53	53	100	50.1	10	–	Months	47	6	Autism
	Szatmari 2000[302]	4- to 6-year-old children (upon entering study) diagnosed by ADI	134	68	51	66.8	–	–	Months	59	7	Autism, Asperger syndrome
Processability test[b]	Carlsson 2013[390]	Children aged from 4.5 to 6.5 years who were assessed to have autism based on DSM-IV criteria	198	119	60	–	–	4.5–6.5	Years	NR	NR	Autistic-like condition, Asperger syndrome, autistic traits
Rating of video for expressive speech[c]	Baghdadli 2012[339]	Age < 7 years, ICD-10 diagnosis of autism	280	280	100	4.9	1.3	–	Months	230	50	Childhood autism, atypical autism
Semistructured free play with examiner[c]	Yoder 2006[428]	21–54 months old with ADOS diagnosis of ASD	36	36	100	33.6	8.4	21–54	Months	NR	NR	Autism, PDD-NOS
Video coding procedures[c]	Colgan 2006[379]	Children aged 8–12 months with diagnosis of autism based on DSM-III-R or DSM-IV criteria	35	21	60	–	–	0–2	Years	17	4	AD

AD, autistic disorder; DD, developmentally delayed; DSM-IV-TR, *Diagnostic and Statistical Manual of Mental Disorders*-Fourth Edition-Text Revision; F, female; M, male; NR, not reported; SD, standard deviation.
a Non-UK.
b Tools developed ad hoc.
c Observational coding.

Cognitive ability	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
Battelle Developmental Inventory (BDI)	Arick 2003[388]	Children between the ages of 2 and 6 years (at baseline) who have been said to have a diagnosis of autism; details of criteria used not provided	67	67	100	–	–	2–6	Years	NR	NR	ASD
Bayley Scales of Infant Development (BSID)	Ben Itzchak 2008[149]	Children aged 19–35 months with autism diagnosis based on DSM-IV criteria	81	44	54	–	–	16–35	Months	43	1	Autism
	Eikeseth 2009[410]	24–42 months with ICD-10 diagnosis of ASD	23	23	100	34.9	5.7	28–42	Months	17	6	Autism
	Eldevik 2012[414]	Children aged 2–6 who had autism diagnosis based on ICD-10 criteria and ADI-R	43	43	100	–	–	1–6	Years	33	10	Autism, PDD-NOS, Asperger
	Grindle 2012[417]	3- to 7-year-old children with autism	29	29	100	–	–	43–72	Months	25	4	Autism
	Ingersoll 2012[286]	27 children between 27 and 47 months old who met DSM-IV-TR criteria	29	29	100	37.9	–	22–47	Months	24	5	AD
	Jonsdottir 2007[341]	Mean age was 41.43 months; diagnosis was based on ICD-10 criteria	41	41	100	41.43	9.06	22–59	Months	34	7	Childhood autism
	Magiati 2007[308]	Children aged between 22 and 54 months who met ADI-R criteria for autism/ASD diagnosis	44	44	100	–	–	22–54	Months	39	5	Autism, ASD
	Peters-Scheffer 2010[421]	3- to 6-year-old children with DSM-IV diagnosis of AD or PDD-NOS	34	34	100	53.5	5.52	42–62	Months	NR	NR	AD, PDD-NOS
	Ray-Subramanian 2011[327]	23–39 months with DSM-IV or ICD-10 diagnosis of ASD	125	125	100	31	4.1	23–39	Months	108	17	Autism, AD, PDD-NOS
	Remington 2007[358]	30–42 months of age with ADI diagnosis of ASD	44	44	100	37	4.2	30–42	Months	NR	NR	Autism or suspected autism
	Rickards 2009[423]	3–5 years, 35/59 diagnosed ASD by DSM-IV criteria	54	54	100	69.65	–	–	Months	43	11	ASD

Cognitive ability	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
	Sheinkopf 1998[429]	23–47 months with DSM-III diagnosis of ASD	22	22	100	–	–	23–47	Months	NR	NR	Autism, PDD-NOS
	Smith 1997[430]	Up to 46 months at intake, within DSM-III diagnosis of ASD	21	21	100	37	–	–	Months	19	2	PDD-NOS
	Smith 2000[413]	18–42 months with 'clinical' diagnosis of ASD	28	28	100	35.92	–	–	Months	23	5	Autism, PDD-NOS
	Stahmer 2004[355]	0–3 years with DSM-IV diagnosis	20	20	100	27.6	–	22–31	Months	16	4	AD, PDD-NOS
	Ventola 2007[332]	16–32 months old with M-CHAT diagnosis of ASD	195	195	100	–	–	16–32	Months	152	43	ASD
	Zachor 2006[334]	Participants were aged 23–33 months and met DSM-IV criteria for autism diagnosis	39	39	100	–	–	23–33	Months	37	2	Autism
Behavior Rating Inventory of Executive Function (BRIEF)-Preschool Version	Jahromi 2013[431]	20 TD and 20 children with high-functioning autism	40	20	50	58.95	11.5	–	Months	36	4	High-functioning autism
British Ability Scale (BAS)	Osborne 2008[350]	2.6–4 years old with GARS diagnosis of ASD	65	65	100	–	–	2.6–4.0	Years	59	6	ASD
	Osborne 2009[351]	2.6–4 years old with GARS diagnosis of ASD	65	65	100	3.4	0.75	2.6–4.0	Years	59	6	ASD
	Reed 2007[352]	2 years 6 months to 4 years old diagnosed with ASD	27	27	100	–	–	2.5–4.0	Years	27	0	ASD
	Reed 2007[353]	2 years 6 months to 4 years old with 'paediatrician' diagnosis of ASD	53	53	100	–	–	2.5–4.0	Years	Unclear	Unclear	ASD
	Reed 2012[354]	2.5–4 years with GARS diagnosis of ASD	66	66	100	40.2	5.6	–	Months	59	7	AD, PDD-NOS

Cognitive ability	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
Cattell Infant Intelligence	Sheinkopf 1998[429]	23–47 months with DSM-III diagnosis of ASD	22	22	100	–	–	23–47	Months	NR	NR	Autism, PDD-NOS
Developmental Profile	Malhi 2011[342]	Children were $\leq$ 3 years at start of the study and had an ASD diagnosis based on DSM-IV criteria	77	77	100	–	–	0–3	Years	64	13	AD, PDD-NOS
Griffiths Mental Developmental Scales	Andersson 2013[409]	Children aged 1.8–3.9 years who met DSM-IV criteria	40	37	93	–	–	1.8–3.9	Years	18	19	AD, ASD, atypical autism, Asperger syndrome
	Carlsson 2013[390]	Children aged from 4.5 to 6.5 years who were assessed to have autism based on DSM-IV criteria	198	119	60	–	–	4.5–6.5	Years	NR	NR	Autistic-like condition, Asperger syndrome, autistic traits
	Hedvall 2013[418]	3.6- to 6.6-year-old children with ASD	190	168	88	55	0.8	42–76	Months	147	21	AD, PDD-NOS, Asperger syndrome
	Lerna 2012[325]	18–60 months old with diagnosis of autism and little or no functional language	18	18	100	–	–	18–60	Months	17	1	Autism
	Strauss 2012[329]	26–81 months with DSM-IV diagnosis of ASD	44	44	100	–	–	26–81	Months	41	3	Autism, PDD-NOS
Leiter International Performance Scale-Revised (Leiter-R)	Gabriels 2007[416]	Children had a mean age of 31 months and had a clinical diagnosis of autistic disorder or PDD-NOS based on DSM-IV criteria	14	14	100	31	–	–	Months	10	4	AD, PDD-NOS
	Grindle 2012[417]	3- to 7-year-old children with autism	29	29	100	–	–	43–72	Months	25	4	Autism
Leiter Performance Scales (Arthur adaptation)	Bennett 2008[296]	Children aged between 4 and 6 years	64	64	100	–	–	4–6	Years	57	7	Asperger syndrome, high-functioning autism
McCarthy Scales of Children's Abilities	Szatmari 2000[302]	4- to 6-year-old children (upon entering study) diagnosed by ADI	134	68	51	66.8	–	–	Months	59	7	Autism, Asperger syndrome

Cognitive ability	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
Merrill–Palmer Scale of Mental Tests	Eikeseth 2009[410]	24–42 months with ICD-10 diagnosis of ASD	23	23	100	34.9	5.7	28–42	Months	17	6	Autism
	Magiati 2007[308]	Children aged between 22 and 54 months who met ADI-R criteria for autism/ASD diagnosis	44	44	100	–	–	22–54	Months	39	5	Autism, ASD
	Sheinkopf 1998[429]	23–47 months with DSM-III diagnosis of ASD	22	22	100	–	–	23–47	Months	NR	NR	Autism, PDD-NOS
	Sheinkopf 2000[412]	Mean age ranged from 36.09 months (SD = 11.23) to 44.07 months (SD = 8.35) with CARS diagnosis of ASD	26	15	58	36.09	–	–	Months	22	4	Autism
	Smith 2000[413]	18–42 months with 'clinical' diagnosis of ASD	28	28	100	35.92	–	–	Months	23	5	Autism, PDD-NOS
	Smith 2010[359]	All < 6 years with ADOS/ADI/DSM-IV diagnosis of ASD	53	53	100	50.1	10	–	Months	47	6	Autism
Mullen Scales of Early Learning (MSEL)	Akshoomoff 2006[395]	16–43 months with ADI-R and ADOS diagnosis of ASD	42	22	52	–	–	16–43	Months	17	5	Autism, ASD
	Anan 2008[396]	25- to 68-month-old children who met the diagnosis of ASD based on DSM-IV criteria	72	72	100	–	–	25–68	Months	61	11	AD, PDD-NOS
	Baker 2010[397]	33 'at-risk' children, entered study between ages of 2–18 months, assessed at 18, 24, 30 and 36 months. [24 of the 33 children had a sibling with ASD or PDD (DSM-IV diagnosed)]	33	12	36	18	–	–	Months	NR	NR	ASD
	Barbaro 2012[398]	12- to 22-month children with AD, ASD or DD/language delay	154	125	81	–	–	12–27	Months	100	25	AD, ASD
	Ben Itzchak 2011[320]	Children aged 15–35 months were included in the study	78	78	100	–	–	15–35	Months	71	7	Autism
	Bishop 2011[176]	Children were aged between 2 years to 5 years 11 months	72	53	74	–	–	1–68	Months	44	9	Not given

Cognitive ability	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
	Brian 2008[305]	Children had no diagnosis of ASD but were followed up to 36 months at which point some were diagnosed of ASD	228	35	15	–	–	6–12	Months	NR	NR	Autism, Asperger syndrome, PDD-NOS
	Dawson 2010[321]	18–30 months, diagnosed by ADOS, ADI and DSM-IV	48	48	100	–	–	18–31	Months	37	11	AD, PDD-NOS
	Dereu 2012[365]	Children aged 2–4 years; ADOS was used for diagnosis	17	9	53	–	–	17–39	Months	6	3	ASD
	Eapen 2013[357]	Mean age of 49.6 months	26	26	100	49.6	6.08	36–58	Months	21	5	AD
	Hartley 2009[323]	Children aged 1.5 to 3.9 years based on DSM-IV TR criteria and ADOS-G classification	499	199	40	–	–	18–49	Months	157	42	AD, PDD-NOS
	Honey 2008[307]	24–48 months diagnosed by ICD-10 criteria	104	79	76	37.05	6.08	24–48	Months	65	14	ASD
	Landa 2012[399]	Assessed at aged 6–36 months – 52/197 subsequently diagnosed ASD by ADOS	204	52	25	6	–	–	Months	43	9	ASD
	Landa 2012[224]	22- to 33-month-old children with ASD or autism	48	48	100	27	2.8	22–33	Months	39	9	ASD
	Lloyd 2013[400]	12- to 36-month-old children with ASD	162	162	100	–	–	12–36	Months	140	22	ASD
	Luyster 2008[129]	Participants were aged 18–33 months and met ADI-R criteria for ASD diagnosis	164	164	100	–	–	18–33	Months	129	35	ASD
	Mayo 2013[310]	45–72 months with DSM-IV-TR criteria	119	119	100	52.22	6.09	45–72	Months	99	20	AD, PDD-NOS
	Mitchell 2006[392]	'At risk' children with a sibling with 'clinical' diagnosis of ASD – 11–15 months at first assessment	146	15	10	–	–	11–15	Months	10	5	ASD
	O'Donnell 2012[386]	3–4 years old with DSM-IV diagnosis of ASD	42	42	100	45.5	–	36–59	Months	NR	NR	Autism, PDD-NOS

Cognitive ability	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
	Ozonoff 2010[313]	Assessed between 6 and 36 months, diagnosed using ADOS	50	25	50	–	–	6	Months	19	6	AD, PDD-NOS
	Poon 2012[401]	9–12 months (upon entering study) with ADOS, ADI or CARS diagnosis of ASD	29	29	100	4.46	1.49	–	Months	24	5	AD, PDD-NOS, Asperger syndrome
	Ray-Subramanian 2012[328]	2–3 years with DSM-IV diagnosis	115	115	100	31	4.1	–	Months	97	18	Autism, AD, PDD-NOS
	Rogers 2012[317]	14–24 months with ASD	98	98	100	21	–	–	Months	76	22	ASD
	Schertz 2013[402]	Mean age 24.6 and 27.5 months with ADOS diagnosis	23	23	100	26.05	–	–	Months	NR	NR	ASD
	Siller 2013[403]	32–82 months with ADI-R and ADOS-G diagnosis	70	70	100	–	–	32–82	Months	64	6	AD
	Sullivan 2007[330]	Tested at 14–24 months and 30–36 months who met DSM-IV criteria for diagnosis	51	16	31	–	–	14–36	Months	14	2	Autism, PDD-NOS
	Tek 2012[331]	16–38 months with ADOS diagnosis	84	84	100	27	–	16–38	Months	NR	NR	ASD
	Thurm 2007[404]	2–3 years and 4–5 years	118	83	70	29.98	4.28	–	Months	71	12	Autism, PDD-NOS
	Toth 2006[284]	34–52 months with ADI-diagnosis of ASD	60	60	100	43.6	4.3	34–52	Months	51	9	AD, PDD-NOS
	Ventola 2007[332]	16–32 months old with M-CHAT diagnosis of ASD	195	195	100	–	–	16–32	Months	152	43	ASD
	Werner 2005[316]	12–57 months with DSM-IV diagnosis of ASD	145	72	50	43.5	4.3	–	Months	60	12	AD, PDD-NOS
	Zachor 2010[335]	15- to 35-month-old children who met DSM-IV criteria	71	71	100	25.55	4.25	15–35	Months	71	7	Autism
Snijders–Oomen Non-Verbal Intelligence Test (SON)	Peters-Scheffer 2010[421]	3- to 6-year-old children with DSM-IV diagnosis of AD or PDD-NOS	34	34	100	53.5	5.52	42–62	Months	NR	NR	AD, PDD-NOS

Cognitive ability	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
Stanford–Binet Intelligence Scales	Ben Itzchak 2008[149]	Children aged 19–35 months with autism diagnosis based on DSM-IV criteria	81	44	54	–	–	16–35	Months	43	1	Autism
	Delmolino 2006[432]	Mean age was 44 months (range = 37–60 months). Diagnosis were made prior to inclusion in the study and confirmed using ADOS and ADI-R	27	27	100	–	–	3–6	Years	23	4	Autism, PDD-NOS
	Grindle 2012[417]	3- to 7-year-old children with autism	29	29	100	–	–	43–72	Months	25	4	Autism
	Harris 1991[408]	Preschool children with a diagnosis of autism based on DSM-III and DSM-III-R criteria	46	25	54	53.245	–	40–67	Months	21	4	Autism
	Harris 2000[433]	Children between the age of 31 and 65 months who had a diagnosis of autistic disorder based on DSM-III-R criteria	27	27	100	–	–	31–65	Months	25	2	AD
	Landa 2012[224]	22- to 33-month-old children with ASD or autism	48	48	100	27	2.8	22–33	Months	39	9	ASD
	Remington 2007[358]	30–42 months of age with ADI diagnosis of ASD	44	44	100	37	4.2	30–42	Months	NR	NR	Autism or suspected autism
	Smith 2000[413]	18–42 months with 'clinical' diagnosis of ASD	28	28	100	35.92	–	–	Months	23	5	Autism, PDD-NOS
	Szatmari 2000[302]	4- to 6-year-old children (upon entering study) diagnosed by ADI	134	68	51	66.8	–	–	Months	59	7	Autism, Asperger syndrome
	Zachor 2006[334]	Participants were aged 23–33 months and met DSM-IV criteria for autism diagnosis	39	39	100	–	–	23–33	Months	37	2	Autism

Cognitive ability	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
Wechsler Intelligence Scale for Children	Szatmari 2000[302]	4- to 6-year-old children (upon entering study) diagnosed by ADI	134	68	51	66.8	–	–	Months	59	7	Autism, Asperger syndrome
Wechsler Preschool and Primary Scale of Intelligence (WPPSI)	Andersson 2013[409]	Children aged 1.8–3.9 years who met DSM-IV criteria	40	37	93	–	–	1.8–3.9	Years	18	19	AD, ASD, atypical autism, Asperger syndrome
	Baghdadli 2012[339]	Age < 7 years, ICD-10 diagnosis of autism	280	280	100	4.9	1.3	–	Months	230	50	Childhood autism, atypical autism
	Baghdadli 2012[339]	Age < 7 years, ICD-10 diagnosis of autism	280	280	100	4.9	1.3	–	Months	230	50	Childhood autism, atypical autism
	Carlsson 2013[390]	Children aged from 4.5 to 6.5 years who were assessed to have autism based on DSM-IV criteria	198	119	60	–	–	4.5–6.5	Years	NR	NR	Autistic-like condition, Asperger syndrome, autistic traits
	Eikeseth 2009[410]	24–42 months with ICD-10 diagnosis of ASD	23	23	100	34.9	5.7	28–42	Months	17	6	Autism
	Hedvall 2013[418]	3.6- to 6.6-year-old children with ASD	190	168	88	55	0.8	42–76	Months	147	21	AD, PDD-NOS, Asperger syndrome
	Jonsdottir 2007[341]	Mean age was 41.43 months; diagnosis was based on ICD-10 criteria	41	41	100	41.43	9.06	22–59	Months	34	7	Childhood autism
	Magiati 2007[308]	Children aged between 22 and 54 months who met ADI-R criteria for autism/ASD diagnosis	44	44	100	–	–	22–54	Months	39	5	Autism, ASD
	Rickards 2009[423]	3–5 years, 35/59 diagnosed ASD by DSM-IV criteria	54	54	100	69.65	–	–	Months	43	11	ASD
	Sheinkopf 1998[429]	23–47 months with DSM-III diagnosis of ASD	22	22	100	–	–	23–47	Months	NR	NR	Autism, PDD-NOS

Cognitive ability	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
Differential Ability Scales[a]	Bishop 2011[176]	Children were aged between 2 years to 5 years 11 months	72	53	74	–	–	1–68	Months	44	9	Not given
	Ruble 2008[424]	40–71 months with DSM-IV diagnosis of ASD	35	35	100	55.9	–	40.9–70.9	Months	30	5	Autism
	Thurm 2007[404]	2–3 years and 4–5 years	118	83	70	29.98	4.28	–	Months	71	12	Autism, PDD-NOS
Kyoto scale of psychological development[a]	Takeda 2005[360]	23–35 months with DSM-IV criteria	57	57	100	31.4	3.3	23–35	Months	45	12	AD, PDD-NOS, Asperger syndrome
Tanaka-Binet intelligence test (Japanese version of Stanford–Binet)[a]	Takeda 2005[360]	23–35 months with DSM-IV criteria	57	57	100	31.4	3.3	23–35	Months	45	12	AD, PDD-NOS, Asperger syndrome
Snabbt Performance test Pa Intelligence IQ II (SPIQ) – Swedish[a]	Carlsson 2013[390]	Children aged from 4.5 to 6.5 years who were assessed to have autism based on DSM-IV criteria	198	119	60	–	–	4.5–6.5	Years	NR	NR	Autistic-like condition, Asperger syndrome, autistic traits

AD, autistic disorder; DD, developmentally delayed; F, female; M, male; NR, not reported; SD, standard deviation; TD, typically developing.
a Non-UK.

Attention	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
Behavior Assessment System for Children-Second Edition (BASC-2)	Hill-Chapman 2013[434]	Parents of children with ASD	56 (parents)	56	100	3.98	1.31	–	Years	N/A	N/A	AD, PDD-NOS, Asperger syndrome
Child Behavior Scale (CBS)	Jahromi 2013[431]	20 TD and 20 children with high-functioning autism	40	20	50	58.95	11.5	–	Months	36	4	High-functioning autism
	Meek 2012[435]	2.75–6.5 years with ADI diagnosis of ASD	40	20	50	58.95	11.5	–	Months	36	4	Autism
Child Behavior Checklist (CBCL) Effortful control Conners Rating Scales-Revised	Baker 2010[397]	33 'at-risk' children, entered study between ages of 2–18 months, assessed at 18, 24, 30 and 36 months. [24 of the 33 children had a sibling with ASD or PDD (DSM-IV diagnosed)]	33	12	36	18	–	–	Months	NR	NR	ASD
	Hartley 2009[323]	Children aged 1.5 to 3.9 years based on DSM-IV-TR criteria and ADOS-G classification	499	199	40	–	–	18–48	Months	157	42	AD, PDD-NOS
	Peters-Scheffer 2010[421]	3- to 6-year-old children with DSM-IV diagnosis of AD or PDD-NOS	34	34	100	53.5	5.52	42–62	Months	NR	NR	AD, PDD-NOS
	Smith 2000[413]	18–42 months with 'clinical' diagnosis of ASD	28	28	100	35.92	–	–	Months	23	5	Autism, PDD-NOS
	Smith 2010[359]	All < 6 years with ADOS/ADI/ DSM-IV diagnosis of ASD	53	53	100	50.1	10	–	Months	47	6	Autism
	Taylor 2012[436]	Mothers of ASD children aged mean 3.72 years (SD = 1.82) and 4.18 (SD = 2.65) at diagnosis	75 (mothers)	75	100	3.72	18.2	–	Months	NR	NR	ASD
	Jahromi 2013[431]	20 TD and 20 children with high-functioning autism	40	20	50	58.95	11.5	–	Months	36	4	High-functioning autism
	Escalona 2001[271]	Children were aged 3–6 years based on DSM III – R	20	20	100	5.2	1.8	3–6	Years	12	8	Autism

Attention	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
	Osborne 2009[351]	2.6–4 years old with GARS diagnosis of ASD	65	65	100	3.4	0.75	2.6–4.0	Years	59	6	ASD
	Reed 2007[353]	2 years 6 months to 4 years old with 'paediatrician' diagnosis of ASD	53	53	100	–	–	2.5–4.0	Years	NR	NR	ASD
	Reed 2013[437]	–	52	52	100	44.4	7.9	36.77	Months	46	6	Childhood autism, PDD-NOS
Student attention – coded observation[a]	Travers 2011[438]	3–6 years meeting a 'state educational definition of Autism'	17	17	100	–	–	3–6	Years	NR	NR	Autism

AD, autistic disorder; DSM-IV-TR, *Diagnostic and Statistical Manual of Mental Disorders*-Fourth Edition-Text Revision; F, female; M, male; N/A, not available; NR, not reported; SD, standard deviation; TD, typically developing.
a Observational coding.

Emotion regulation	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
Baby and Infant Screen for Children with aUtIsm Traits (BISCUIT-Part 2)	Davis 2010[439]	Toddlers (17–37 months) with a diagnosis of AD	513	313	61	27.09	5.02	17–37	Months	371	142	AD, PDD-NOS
Behavior Assessment System for Children-Second Edition (BASC-2)	Hill-Chapman 2013[434]	Parents of children with ASD	56 (parents)	56	100	3.98	1.31	–	Years	N/A	N/A	AD, PDD-NOS, Asperger syndrome
Child Behavior Checklist (CBCL)	Baker 2010[397]	33 'at-risk' children, entered study between ages of 2–18 months, assessed at 18, 24, 30 and 36 months. [24 of the 33 children had a sibling with ASD or PDD (DSM-IV diagnosed)]	33	12	36	18	–	–	Months	NR	NR	ASD
	Hartley 2009[323]	Children aged 1.5–3.9 years based on DSM-IV-TR criteria and ADOS-G classification	499	199	40	–	–	18–48	Months	157	42	AD, PDD-NOS
	Peters-Scheffer 2010[421]	3- to 6-year-old children with DSM-IV diagnosis of AD or PDD-NOS	34	34	100	53.5	5.52	42–62	Months	NR	NR	AD, PDD-NOS
	Smith 2000[413]	18–42 months with 'clinical' diagnosis of ASD	28	28	100	35.92	–	–	Months	23	5	Autism, PDD-NOS
	Smith 2010[359]	All < 6 years with ADOS/ADI/DSM-IV diagnosis of ASD	53	53	100	50.1	10	–	Months	47	6	Autism
	Taylor 2012[436]	Mothers of ASD children aged mean 3.72 years (SD = 1.82) and 4.18 (SD = 2.65) at diagnosis	75 (mothers)	75	100	3.72	18.2	–	Months	NR	NR	ASD
Children's Global Assessment Scale (CGAS)	Andersson 2013[409]	Children aged 1.8 to 3.9 years who met DSM-IV criteria	40	37	93	–	–	1.8–3.9	Years	18	19	AD, ASD, atypical autism, Asperger syndrome

Emotion regulation	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
Conners Rating Scales-Revised	Escalona 2001[271]	Children were aged 3–6 years based on DSM-III-R	20	20	100	5.2	1.8	3–6	Years	12	8	Autism
	Osborne 2009[351]	2.6–4 years old with GARS diagnosis of ASD	65	65	100	3.4	0.75	2.6–4.0	Years	59	6	ASD
	Reed 2007[353]	2 years 6 months to 4 years old with 'paediatrician' diagnosis of ASD	53	53	100	–	–	2.5–4.0	Years	NR	NR	ASD
	Reed 2013[437]	–	52	52	100	44.4	7.9	36.77	Months	46	6	Childhood autism, PDD-NOS
Developmental Behaviour Checklist	Herring 2006[411]	Children were aged between 20 and 51 months who met the DSM-IV criteria for diagnosis	123	84	68	37.75	7.07	–	Months	75	9	AD, PDD-NOS
	Mooney 2006[311]	22–51 months with DSM-IV diagnosis of ASD	55	40	73	36.95	7.26	22–51	Months	34	6	AD
	Remington 2007[358]	30–42 months of age with ADI diagnosis of ASD	44	44	100	37	4.2	30–42	Months	NR	NR	Autism or suspected autism
	Roberts 2011[405]	2.2–5 years with DSM-IV diagnosis of ASD	95	95	100	–	–	26.3–60.3	Months	86	9	AD, ASD
	Tonge 2012[425]	Children were aged 2.5–5 years and diagnosis was made using a combination of medical reviews, ADI-R and CARS	107	107	100	–	–	2.5–5.0	Years	90	17	AD
Emotion Regulation Checklist	Jahromi 2013[431]	20 TD and 20 children with high-functioning autism	40	20	50	58.95	11.5	–	Months	36	4	High-functioning autism
Infant–Toddler Social–Emotional Assessment (ITSEA)	Ben-Sasson 2008[382]	18–33 months old children, diagnosed by ADOS and ADI	170	170	100	28	4	18–33	Months	133	37	AD, PDD-NOS

AD, autistic disorder; DSM-IV-TR, *Diagnostic and Statistical Manual of Mental Disorders*-Fourth Edition-Text Revision; F, female; M, male; N/A, not available; NR, not reported; SD, standard deviation; TD, typically developing.

Physical skills	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
Annett's Pegs	Szatmari 2000[302]	4- to 6-year-old children (upon entering study) diagnosed by ADI	134	68	51	66.8	–	–	Months	59	7	Autism, Asperger syndrome
Beery Visual–Motor Integration Test	Szatmari 2000[302]	4- to 6-year-old children (upon entering study) diagnosed by ADI	134	68	51	66.8	–	–	Months	59	7	Autism, Asperger syndrome
Brunet–Lezine's Oculomotor Coordination Subtest	Baghdadli 2012[339]	Age < 7 years, ICD-10 diagnosis of autism	280	280	100	4.9	1.3	–	Months	230	50	Childhood autism, atypical autism
Functional Independence Measure for Children (WeeFIM)	Jasmin 2009[384]	Children aged 3–4 years who had a diagnosis of ASD based on DSM-IV criteria	35	35	100	–	–	3–4	Years	32	3	Autistic, PDD-NOS, Asperger syndrome
Infant Motor Maturity and Atypicality Coding Scales	Ozonoff 2008[440]	16–61 months with DSM-IV diagnosis of ASD	103	54	52	–	–	26–61	Months	48	6	AD, PDD-NOS
Mullen Scales of Early Learning (MSEL)	Akshoomoff 2006[395]	16–43 months with ADI-R and ADOS diagnosis of ASD	42	22	52	–	–	16–43	Months	17	5	Autism, ASD
	Anan 2008[396]	25- to 68-month-old children who met the diagnosis of ASD based on DSM-IV criteria	72	72	100	–	–	25–68	Months	61	11	AD, PDD-NOS
	Baker 2010[397]	33 'at-risk' children, entered study between ages of 2–18 months, assessed at 18, 24, 30 and 36 months. [24 of the 33 children had a sibling with ASD or PDD (DSM-IV diagnosed)]	33	12	36	18	–	–	Months	NR	NR	ASD
	Barbaro 2012[398]	12- to 22-month children with AD, ASD or DD/language delay	154	125	81	–	–	12–27	Months	100	25	AD, ASD
	Ben Itzchak 2011[320]	Children aged 15–35 months were included in the study	78	78	100	–	–	15–35	Months	71	7	Autism
	Bishop 2011[176]	Children were aged between 2 years to 5 years 11 months	72	53	74	–	–	1–68	Months	44	9	Not given

Physical skills	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
	Brian 2008[305]	Children had no diagnosis of ASD but were followed up to 36 months at which point some were diagnosed of ASD	228	35	15	–	–	6–12	Months	NR	NR	Autism, Asperger syndrome, PDD-NOS
	Dawson 2010[321]	18–30 months, diagnosed by ADOS, ADI and DSM-IV	48	48	100	–	–	18–31	Months	37	11	AD, PDD-NOS
	Dereu 2012[365]	Children aged 2–4 years; ADOS was used for diagnosis	17	9	53	–	–	17–39	Months	6	3	ASD
	Eapen 2013[357]	Mean age of 49.6 months	26	26	100	49.6	6.08	36–58	Months	21	5	AD
	Hartley 2009[323]	Children aged 1.5 to 3.9 years based on DSM-IV-TR criteria and ADOS-G classification	499	199	40	–	–	18–49	Months	157	42	AD, PDD-NOS
	Honey 2008[307]	24–48 months diagnosed by ICD-10 criteria	104	79	76	37.05	6.08	24–48	Months	65	14	ASD
	Landa 2012[399]	Assessed at aged 6–36 months – 52/197 subsequently diagnosed ASD by ADOS	204	52	25	6	–	–	Months	43	9	ASD
	Landa 2012[224]	22- to 33-month-old children with ASD or autism	48	48	100	27	2.8	22–33	Months	39	9	ASD
	Lloyd 2013[400]	12- to 36-month-old children with ASD	162	162	100	–	–	12–36	Months	140	22	ASD
	Luyster 2008[129]	Participants were aged 18–33 months and met ADI-R criteria for ASD diagnosis	164	164	100	–	–	18–33	Months	129	35	ASD
	Mayo 2013[310]	45–72 months with DSM-IV-TR criteria	119	119	100	52.22	6.09	45–72	Months	99	20	AD, PDD-NOS
	Mitchell 2006[392]	'At risk' children with a sibling with 'clinical' diagnosis of ASD – 11–15 months at first assessment	146	15	10	–	–	11–15	Months	10	5	ASD
	O'Donnell 2012[386]	3–4 years old with DSM-IV diagnosis of ASD	42	42	100	45.5	–	36–59	Months	NR	NR	Autism, PDD-NOS

Physical skills	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
	Ozonoff 2010[313]	Assessed between 6 and 36 months, diagnosed using ADOS	50	25	50	–	–	6	Months	19	6	AD, PDD-NOS
	Poon 2012[401]	9–12 months (upon entering study) with ADOS, ADI or CARS diagnosis of ASD	29	29	100	4.46	1.49	–	Months	24	5	AD, PDD-NOS, Asperger syndrome
	Ray-Subramanian 2012[328]	2–3 years with DSM-IV diagnosis	115	115	100	31	4.1	–	Months	97	18	Autism, AD, PDD-NOS
	Rogers 2012[317]	14–24 months with ASD	98	98	100	21	–	–	Months	76	22	ASD
	Schertz 2013[402]	Mean age 24.6 and 27.5 months with ADOS diagnosis	23	23	100	26.05	–	–	Months	NR	NR	ASD
	Siller 2013[403]	32–82 months with ADI-R and ADOS-G diagnosis	70	70	100	–	–	32–82	Months	64	6	AD
	Sullivan 2007[330]	Tested at 14–24 months and 30–36 months who met DSM-IV criteria for diagnosis	51	16	31	–	–	14–36	Months	14	2	Autism, PDD-NOS
	Tek 2012[331]	16–38 months with ADOS diagnosis	84	84	100	27	–	16–38	Months	NR	NR	ASD
	Thurm 2007[404]	2–3 years and 4–5 years	118	83	70	29.98	4.28	–	Months	71	12	Autism, PDD-NOS
	Toth 2006[284]	34–52 months with ADI-diagnosis of ASD	60	60	100	43.6	4.3	34–52	Months	51	9	AD, PDD-NOS
	Ventola 2007[332]	16–32 months old with M-CHAT diagnosis of ASD	195	195	100	–	–	16–32	Months	152	43	ASD
	Werner 2005[316]	12–57 months with DSM-IV diagnosis of ASD	145	72	50	43.5	4.3	–	Months	60	12	AD, PDD-NOS
	Zachor 2010[335]	15- to 35-month-old children who met DSM-IV criteria	71	71	100	25.55	4.25	15–35	Months	71	7	Autism

Physical skills	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
Peabody Developmental Motor Scales	Jasmin 2009[384]	Children aged 3–4 years who had a diagnosis of ASD based on DSM-IV criteria	35	35	100	–	–	3–4	Years	32	3	Autistic, PDD-NOS, Asperger syndrome
	Provost 2007[441]	21 to 41 month olds with DSM-IV diagnosis of ASD	38	19	50	30.1	4.5	21–41	Months	15	4	Autism, PDD-NOS
Vineland Adaptive Behavior Scales-Classroom version (VABS-Classroom)	Goin-Kochel 2007[427]	Children were aged between 29.6–61.4 months; diagnosis was based on ADOS criteria	29	29	100	45.7	9.6	29.6–61.4	Months	27	2	Autism, PDD-NOS
Vineland Adaptive Behavior Scales (VABS)	Aldred 2004[318]	2 years to 5 years 11 months with ADI diagnosis	28	28	100	–	–	24–71	Months	25	3	AD or 'classical autism'
	Anan 2008[396]	25 to 68 months old children who met the diagnosis of ASD based on DSM-IV criteria	72	72	100	–	–	25–68	Months	61	11	AD, PDD-NOS
	Andersson 2013[409]	Children aged 1.8 to 3.9 years who met DSM-IV criteria	40	37	93	–	–	1.8–3.9	Years	18	19	AD, ASD, atypical autism, Asperger syndrome
	Arick 2003[388]	Children between the ages of 2 and 6 years (at baseline) who have been said to have a diagnosis of autism; details of criteria used not provided	67	67	100	–	–	2–6	Years	NR	NR	ASD
	Baghdadli 2012[339]	Age < 7 years, ICD-10 diagnosis of autism	280	280	100	4.9	1.3	–	Months	230	50	Childhood autism, atypical autism
	Bearss 2013[278]	Children were aged between 3 years and 6 years 11 months, and assessed to have autism based on ADOS and clinical observation	16	16	100	–	–	3–6	Years	16	0	AD, PDD-NOS
	Ben Itzchak 2011[320]	Children aged 15–35 months were included in the study	78	78	100	–	–	15–35	Months	71	7	Autism
	Bennett 2008[296]	Children aged between 4 and 6 years	64	64	100	–	–	4–6	Years	57	7	Asperger syndrome, high-functioning autism

Physical skills	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
	Carlsson 2013[390]	Children aged from 4.5 to 6.5 years who were assessed to have autism based on DSM-IV criteria	198	119	60	–	–	4.5–6.5	Years	NR	NR	Autistic-like condition, Asperger syndrome, autistic traits
	Cassidy 2008[348]	Parents of children aged < 5 years with ICD-10 diagnosis of ASD	104	104	100	–	–	2–4	Years	95	9	ASD
	Dawson 2010[321]	18–30 months, diagnosed by ADOS, ADI and DSM-IV	48	48	100	–	–	18–33	Months	37	11	AD, PDD-NOS
	Eapen 2013[357]	Mean age of 49.6 months	26	26	100	49.6	6.08	36–58	Months	21	5	AD
	Eikeseth 2009[410]	24–42 months with ICD-10 diagnosis of ASD	23	23	100	34.9	5.7	28–42	Months	17	6	Autism
	Eldevik 2012[414]	Children aged 2 to 6 who had autism diagnosis based on ICD-10 criteria and ADI-R	43	43	100	4.26	1.48	1–6	Years	33	10	Autism, PDD-NOS, Asperger
	Eriksson 2013[415]	Children aged 20–54 months. Criteria not stated	208	208	100	–	–	20–54	Months	176	32	ASD
	Gabriels 2007[416]	Children had a mean age of 31 months and had a clinical diagnosis of autistic disorder or PDD-NOS based on DSM-IV criteria	14	14	100	31	–	–	Months	10	4	AD, PDD-NOS
	Green 2010[253]	24–60 months, ADOS or ADI diagnosed	152	152	100	45	–	24–60	Months	138	14	Core autism
	Grindle 2012[417]	3- to 7-year-old children with autism	29	29	100	–	–	43–72	Months	25	4	Autism
	Hedvall 2013[418]	3.6- to 6.6-year-old children with ASD	190	168	88	55	0.8	42–76	Months	147	21	AD, PDD-NOS, Asperger syndrome
	Herring 2006[411]	Children were aged between 20 and 51 months who met the DSM-IV criteria for diagnosis	123	84	68	37.75	7.07	–	Months	75	9	AD, PDD-NOS
	Honey 2008[307]	24–48 months diagnosed by ICD-10 criteria	104	79	76	37.05	6.08	24–48	Months	65	14	ASD

Physical skills	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
	Hudry 2010[233]	24- to 59-month-old children with ADOS-G diagnosis	152	152	100	44.83	7.98	24–59	Months	138	14	Core autism
	Jasmin 2009[384]	Children aged 3–4 years who had a diagnosis of ASD based on DSM-IV criteria	35	35	100	–	–	3–4	Years	32	3	Autistic, PDD-NOS, Asperger syndrome
	Jonsdottir 2007[341]	Mean age was 41.43 months; diagnosis was based on ICD-10 criteria	41	41	100	41.43	9.06	22–59	Months	34	7	Childhood autism
	Klintwall 2012[419]	2 years and 3 months to 4 years and 11 months, with clinical diagnosis by paediatrician	21	21	100	3.6	–	2.25–4.9	Years	16	5	Autism
	Landa 2012[224]	22- to 33-month-old children with ASD or autism	48	48	100	27	2.8	22–33	Months	39	9	ASD
Vineland Adaptive Behavior Scales-Second Edition (Vineland-II)	Lerna 2012[325]	18–60 months old with diagnosis of autism and little or no functional language	18	18	100	–	–	18–60	Months	17	1	Autism
Vineland Adaptive Behavior Scales (VABS)	Lloyd 2013[400]	12- to 36-month-old children with ASD	162	162	100	–	–	12–37	Months	140	22	ASD
Vineland Adaptive Behavior Scales-Expanded Form	Luyster 2008[129]	Participants were aged 18–33 months and met ADI-R criteria for ASD diagnosis	164	164	100	–	–	18–33	Months	129	35	ASD
Vineland Adaptive Behavior Scales (VABS)	Magiati 2007[308]	Children aged between 22 and 54 months who met ADI-R criteria for autism/ASD diagnosis	44	44	100	–	–	22–54	Months	39	5	Autism, ASD
	Magiati 2011[309]	Mean age of 3.4 years at start of the study	44	44	100	38.9	7.1	27–55	Months	39	5	Autism, ASD
	Mayo 2013[310]	45–72 months with DSM-IV-TR criteria	119	119	100	52.22	6.09	45–72	Months	99	20	AD, PDD-NOS

Physical skills	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
	McConkey 2010[349]	Children with ASD diagnosis (criteria not given, it was only stated as 'confirmed diagnosis of ASD from a specialist clinic') who had a mean age of 2.8 years at start of the study	62 (families)	61	98	–	–	< 4	Years	55	6	Autism
	Munson 2006[420]	38–54 months with DSM-IV diagnosis of ASD	45	45	100	47.4	4.2	38–54	Months	38	7	AD, PDD-NOS
	Munson 2008[312]	24–66 months with ADI or ADOS diagnosis of ASD	456	456	100	43.4	8.7	24–66	Months	370	86	Autism, ASD
	O'Donnell 2012[386]	3–4 years old with DSM-IV diagnosis of ASD	42	42	100	45.5	–	36–59	Months	NR	NR	Autism, PDD-NOS
	Osborne 2008[350]	2.6–4 years old with GARS diagnosis of ASD	65	65	100	–	–	2.6–4.0	Years	59	6	ASD
	Osborne 2009[351]	2.6–4 years old with GARS diagnosis of ASD	65	65	100	3.4	0.75	2.6–4.0	Years	59	6	ASD
	Peters-Scheffer 2010[421]	3- to 6-year-old children with DSM-IV diagnosis of AD or PDD-NOS	34	34	100	53.5	5.52	42–62	Months	NR	NR	AD, PDD-NOS
	Poon 2012[401]	9–12 months (upon entering study) with ADOS, ADI or CARS diagnosis of ASD	29	29	100	4.46	1.49	–	Months	24	5	AD, PDD-NOS, Asperger syndrome
	Pry 2005[314]	21 months to 7 years with ICD-10 diagnosis of ASD	222	222	100	5	1.75	1.75–7	Years	180	42	Infantile autism
	Ray-Subramanian 2011[327]	23–39 months with DSM-IV or ICD-10 diagnosis of ASD	125	125	100	31	4.1	23–39	Months	108	17	Autism, AD, PDD-NOS
	Reed 2007[352]	2 years 6 months to 4 years old diagnosed with ASD	27	27	100	–	–	2.5–4.0	Years	27	0	ASD
	Reed 2007[353]	2 years 6 months to 4 years old with 'paediatrician' diagnosis of ASD	53	53	100	–	–	2.5–4.0	Years	Unclear	Unclear	ASD
	Reed 2012[354]	2.5–4 years with GARS diagnosis of ASD	66	66	100	40.2	5.6	–	Months	59	7	AD, PDD-NOS

Physical skills	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
	Remington 2007[358]	30–42 months of age with ADI diagnosis of ASD	44	44	100	37	4.2	30–42	Months	NR	NR	Autism or suspected autism
	Restall 1994[422]	3–6 years with DSM-III diagnosis of ASD	18	9	50	64.76	6.4	–	Months	8	1	Autism
	Rickards 2009[423]	3–5 years, 35/59 diagnosed ASD by DSM-IV criteria	54	54	100	69.65	–	–	Months	43	11	ASD
	Roberts 2011[405]	2.2–5 years with DSM-IV diagnosis of ASD	95	95	100	–	–	26.3–60.3	Months	86	9	AD, ASD
	Rogers 2012[317]	14–24 months with ASD	98	98	100	21	–	–	Months	76	22	ASD
	Ruble 2008[424]	40–71 months with DSM-IV diagnosis of ASD	35	35	100	55.9	–	40.9–70.9	Months	30	5	Autism
	Salt 2002[372]	Preschool children in Scotland, (mean 42.36 months) with ICD-10 diagnosis of ASD	17	17	100	40.015	–	–	Months	14	3	Childhood autism
	Schertz 2013[402]	Mean age 24.6 and 27.5 months with ADOS diagnosis	23	23	100	26.05	–	–	Months	NR	NR	ASD
	Silva 2007[299]	3–6 years old with DSM-IV diagnosis of ASD	15	15	100	4.83	–	3–6	Years	13	2	AD
	Silva 2008[300]	3–6 years old with DSM-IV diagnosis of ASD	26	26	100	56.3	12.5	–	Months	21	5	Autism
	Smith 2000[413]	18–42 months with 'clinical' diagnosis of ASD	28	28	100	35.92	–	–	Months	23	5	Autism, PDD-NOS
	Smith 2010[359]	All < 6 years with ADOS/ADI/ DSM-IV diagnosis of ASD	53	53	100	50.1	10	–	Months	47	6	Autism
	Stahmer 2004[355]	0–3 years with DSM-IV diagnosis	20	20	100	29.6	–	22–33	Months	16	4	AD, PDD-NOS
	Stone 1999[346]	23–35 months with DSM-III or DSM-IV diagnosis of ASD	60	30	50	31.3	3.3	23–35	Months	25	5	Autism
	Strauss 2012[329]	26–81 months with DSM-IV diagnosis of ASD	44	44	100	–	–	26–81	Months	41	3	Autism, PDD-NOS

Physical skills	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
	Szatmari 2000[302]	4- to 6-year-old children (upon entering study) diagnosed by ADI	134	68	51	66.8	–	–	Months	59	7	Autism, Asperger syndrome
	Tonge 2012[425]	Children were aged 2.5–5 years and diagnosis was made using a combination of medical reviews, ADI-R and CARS	107	107	100	–	–	2.5–5.0	Years	90	17	AD
	Toth 2006[284]	34–52 months with ADI-diagnosis of ASD	60	60	100	43.6	4.3	34–52	Months	51	9	AD, PDD-NOS
	VanMeter 1997[426]	Mean ages ranged from 2.9 (SD = 0.77) to 5.7 (SD = 1.31) years meeting DSM-III criteria for ASD	143	57	40	–	–	5.2–6.0	Years	54	3	AD
	Ventola 2007[332]	16–32 months old with M-CHAT diagnosis of ASD	195	195	100	–	–	16–32	Months	152	43	ASD
	Werner 2005[316]	12–57 months with DSM-IV diagnosis of ASD	145	72	50	43.5	4.3	–	Months	60	12	AD, PDD-NOS
	Zachor 2010[335]	15- to 35-month-old children who met DSM-IV criteria	71	71	100	25.55	4.25	15–35	Months	71	7	Autism

AD, autistic disorder; DD, developmentally delayed; DSM-IV-TR, *Diagnostic and Statistical Manual of Mental Disorders*-Fourth Edition-Text Revision; F, female; M, male; NR, not reported; SD, standard deviation.

Social communication	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
Autism Diagnostic Interview (ADI)	Ben Itzchak 2008[149]	Children aged 19–35 months with autism diagnosis based on DSM-IV criteria	81	44	54	–	–	16–35	Months	43	1	Autism
Autism Diagnostic Interview-Revised (ADI-R)	Bennett 2012[304]	Children with ASD aged 2–4 years old	214	178	83	–	–	2–4	Years	181	33	AD, Asperger syndrome, PDD-NOS
	Brian 2008[305]	Children had no diagnosis of ASD but were followed up to 36 months at which point some were diagnosed of ASD	228	35	15	–	–	6–12	Months	NR	NR	Autism, Asperger syndrome, PDD-NOS
	Feldman 2012[104]	Children who aged between 1 and 24 months who were 'at risk' for autism (they had a sibling with a diagnosis of ASD, Asperger syndrome or PDD-NOS)	108 (parents)	108	100	8	5	–	Months	74	34	AD, PDD-NOS, Asperger syndrome and high-functioning autism
	Hambly 2012[306]	Children with ASDs from bilingual and monolingual homes	75	75	100	–	–	36–78	Months	60	15	Autism, ASD, Asperger syndrome, PDD-NOS
	Honey 2008[307]	24–48 months diagnosed by ICD-10 criteria	104	79	76	37.05	6.08	24–48	Months	65	14	ASD
	Magiati 2007[308]	Children aged between 22 and 54 months who met ADI-R criteria for autism/ASD diagnosis	44	44	100	–	–	22–54	Months	39	5	Autism, ASD
	Magiati 2011[309]	Mean age of 3.4 years at start of the study	44	44	100	38.9	7.1	27–55	Months	39	5	Autism, ASD
	Mayo 2013[310]	45–72 months with DSM-IV-TR criteria	119	119	100	52.22	6.09	45–72	Months	99	20	AD, PDD-NOS
	Mooney 2006[311]	22–51 months with DSM-IV diagnosis of ASD	55	40	73	36.95	7.26	22–51	Months	34	6	AD
	Munson 2008[312]	24–66 months with ADI or ADOS diagnosis of ASD	456	456	100	43.4	8.7	24–66	Months	370	86	Autism, ASD

Social communication	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
	Ozonoff 2010[313]	Assessed between 6 and 36 months, diagnosed using ADOS	50	25	50	–	–	6	Months	19	6	AD, PDD-NOS
Autism Diagnostic Interview (ADI)	Pry 2005[314]	21 months to 7 years with ICD-10 diagnosis of ASD	222	222	100	5	1.75	1.75–7.0	Years	180	42	Infantile autism
Autism Diagnostic Interview-Revised (ADI-R)	Richler 2007[315]	Up to 3 years old, with 'clinical' diagnosis of ASD	279	192	69	–	–	0–37	Months	162	30	Autism, PDD-NOS
Autism Diagnostic Interview (ADI)	Werner 2005[316]	12–57 months with DSM-IV diagnosis of ASD	145	72	50	43.5	4.3	–	Months	60	12	AD, PDD-NOS
Autism Diagnostic Observation Scale-Toddler Module (ADOS-T)	Rogers 2012[317]	14–24 months with ASD	98	98	100	21	–	–	Months	76	22	ASD
Autism Diagnostic Observation Schedule (ADOS)	Aldred 2004[318]	2 years to 5 years 11 months with ADI diagnosis	28	28	100	–	–	24–71	Months	25	3	AD or 'classical autism'
	Aldred 2012[319]	Children aged 2–5 years assessed using ADOS and ADI-R	28	28	100	–	–	2–5	Years	25	3	Autism
	Ben Itzchak 2008[149]	Children aged 19–35 months with autism diagnosis based on DSM-IV criteria	81	44	54	–	–	16–35	Months	43	1	Autism
	Ben Itzchak 2011[320]	Children aged 15–35 months were included in the study	78	78	100	–	–	15–35	Months	71	7	Autism
	Bennett 2012[304]	Children with ASD aged 2–4 years old	214	178	83	–	–	2–4	Years	181	33	AD, Asperger syndrome, PDD-NOS
	Brian 2008[305]	Children had no diagnosis of ASD but were followed up to 36 months at which point some were diagnosed of ASD	228	35	15	–	–	6–12	Months	NR	NR	Autism, Asperger syndrome, PDD-NOS
	Dawson 2010[321]	18–30 months, diagnosed by ADOS, ADI and DSM-IV	48	48	100	–	–	18–30	Months	37	11	AD, PDD-NOS

Social communication	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
	Gotham 2012[322]	Best-estimate clinical diagnosis of ASD at one or more time points	345	345	100	3.3	1.4	–	Years	282	63	Autism, PDD-NOS
Autism Diagnostic Observation Schedule-Generic (ADOS-G)	Green 2010[253]	24–60 months, ADOS or ADI diagnosed	152	152	100	45	–	24–60	Months	138	14	Core autism
	Hartley 2009[323]	Children aged 1.5–3.9 years based on DSM-IV-TR criteria and ADOS-G classification	499	199	40	–	–	18–47	Months	157	42	AD, PDD-NOS
Autism Diagnostic Observation Schedule (ADOS)	Landa 2012[224]	22- to 33-month-old children with ASD or autism	48	48	100	27	2.8	22–33	Months	39	9	ASD
	Lerna 2012[325]	18–60 months old with diagnosis of autism and little or no functional language	18	18	100	–	–	18–60	Months	17	1	Autism
	Luyster 2008[129]	Participants were aged 18–33 months and met ADI-R criteria for ASD diagnosis	164	164	100	–	–	18–33	Months	129	35	ASD
Autism Diagnostic Observation Schedule-Generic (ADOS-G)	Munson 2008[312]	24–66 months with ADI or ADOS diagnosis of ASD	456	456	100	43.4	8.7	24–66	Months	370	86	Autism, ASD
	Oosterling 2010[326]	12–42 months old with 'clinical' diagnosis of ASD	80	80	100	34.8	–	–	Months	62	18	Autism, PDD-NOS
	Ray-Subramanian 2011[327]	23–39 months with DSM-IV or ICD-10 diagnosis of ASD	125	125	100	31	4.1	23–39	Months	108	17	Autism, AD, PDD-NOS
	Ray-Subramanian 2012[328]	2–3 years with DSM-IV diagnosis	115	115	100	31	4.1	–	Months	97	18	Autism, AD, PDD-NOS
	Strauss 2012[329]	26–81 months with DSM-IV diagnosis of ASD	44	44	100	–	–	26–81	Months	41	3	Autism, PDD-NOS
	Sullivan 2007[330]	Tested at 14–24 months and 30–36 months who met DSM-IV criteria for diagnosis	51	16	31	–	–	14–36	Months	14	2	Autism, PDD-NOS
	Tek 2012[331]	16–38 months with ADOS diagnosis	84	84	100	27	–	16–38	Months	NR	NR	ASD
	Ventola 2007[332]	16–32 months old with M-CHAT diagnosis of ASD	195	195	100	–	–	16–32	Months	152	43	ASD

Social communication	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
Autism Diagnostic Observation Schedule (ADOS)	Werner 2005[316]	12–57 months with DSM-IV diagnosis of ASD	145	72	50	43.5	4.3	–	Months	60	12	AD, PDD-NOS
	Wong 2010[333]	17–36 months children diagnosed by DSM-IV, ADI and ADOS	17	17	100	–	–	17–36	Months	16	1	–
	Zachor 2006[335]	Participants were aged 23–33 months and met DSM-IV criteria for autism diagnosis	39	39	100	–	–	23–33	Months	37	2	Autism
	Zachor 2010[335]	15- to 35-month-old children who met DSM-IV criteria	71	71	100	25.55	4.25	15–35	Months	71	7	Autism
Autism Screening Instrument for Educational Planning (ASIEP)	Arick 2003[388]	Children between the ages of 2 and 6 years (at baseline) who have been said to have a diagnosis of autism; details of criteria used not provided	67	67	100	–	–	2–6	Years	NR	NR	ASD
Communication and Symbolic Behavior Scales-Developmental Profile (Caregiver Questionnaire) (CSBS-DP-CQ); (Wetherby and Prizant 2002)	Tek 2012[331]	16–38 months with ADOS diagnosis	84	84	100	27	–	16–38	Months	NR	NR	ASD
Early Social Communication Scale (ESCS)	Dereu 2012[365]	Children aged 2–4 years; ADOS was used for diagnosis	17	9	53	–	–	17–39	Months	6	3	ASD
	Goods 2013[366]	36- to 60-month-old children with autism (ADOS assessment)	15	15	100	51.9	–	–	Months	NR	NR	Autism
	Ingersoll 2012[286]	27 children between 27 and 47 months old who met DSM-IV-TR criteria	29	29	100	37.9	–	22–47	Months	24	5	AD
	Kaale 2012[294]	Children aged 29–60 months who had a diagnosis of autistic disorder based on ICD-10 criteria	61	61	100	–	–	24–60	Months	48	13	Autism

Social communication	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
	Kalas 2012[367]	4- to 6-year-old children with ASD	30	30	100	–	–	4–6	Years	28	2	ASD
	Kasari 2006[368]	Children were aged 3 to 4 years and had a diagnosis of autism based on ADI-R and ADOS criteria	58	58	100	–	–	3–4	Years	46	12	Autism
	Lawton 2012[369]	Preschool age children who had a diagnosis of autism, validated by ADI-R	52	52	100	43.05	6.86	–	Months	40	12	Autism
	Luyster 2008[129]	Participants were aged 18–33 months and met ADI-R criteria for ASD diagnosis	164	164	100	–	–	18–33	Months	129	35	ASD
	Paparella 2011[370]	20–72 months old with ADI diagnosis of ASD	83	50	60	53.6	–	36–72	Months	42	8	Autism
	Remington 2007[358]	30–42 months of age with ADI diagnosis of ASD	44	44	100	37	4.2	30–42	Months	NR	NR	Autism or suspected autism
	Roos 2008[371]	30–38 months with ADOS diagnosis of ASD	20	20	100	33.2	–	30–38	Months	16	4	ASD
	Wong 2013[373]	3–6 years with CARS diagnosis	33	33	100	56.79	–	–	Months	29	4	Autism
	Yoder 2006[374]	1.9–4.5 years with ADOS diagnosis of ASD	36	36	100	2.9	–	–	Years	31	5	Autism, PDD-NOS
	Salt 2002[372]	Preschool children in Scotland, (mean 42.36 months) with ICD-10 diagnosis of ASD	17	17	100	40.015	–	–	Months	14	3	Childhood autism
Early Social Communication Scales (ESCS)-Abridged	Yoder 2010[375]	18–60 months with ADOS diagnosis of ASD	36	36	100	2.9	–	–	Years	NR	NR	Autism, PDD-NOS
Pragmatics Profile	Roberts 2011[405]	2.2–5 years with DSM-IV diagnosis of ASD	95	95	100	–	–	26.3–60.3	Months	86	9	AD, ASD
Social Communication Assessment for Toddlers with Autism (SCATA)	Drew 2007[137]	Children aged between 21 to 43 months with a diagnosis of autism or PDD based on ICD-10 criteria	46	46	100	25	5.6, NR	18–44, NR	Months	39	7	Autism, PDD-NOS

Social communication	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
Social Communication Behavior Codes	Ozonoff 2010[313]	Assessed between 6 and 36 months, diagnosed using ADOS	50	25	50	–	–	6	Months	19	6	AD, PDD-NOS
Vineland Adaptive Behavior Scales-Classroom version (VABS-Classroom)	Goin-Kochel 2007[427]	Children were aged between 29.6–61.4 months; diagnosis was based on ADOS criteria	29	29	100	45.7	9.6	29.6–61.4	Months	27	2	Autism, PDD-NOS
Vineland Adaptive Behavior Scales (VABS)	Aldred 2004[318]	2 years to 5 years 11 months with ADI diagnosis	28	28	100	–	–	24–71	Months	25	3	AD or 'classical autism'
	Anan 2008[396]	25 to 68 months old children who met the diagnosis of ASD based on DSM-IV criteria	72	72	100	–	–	25–68	Months	61	11	AD, PDD-NOS
	Andersson 2013[409]	Children aged 1.8 to 3.9 years who met DSM-IV criteria	40	37	93	–	–	1.8–3.9	Years	18	19	AD, ASD, atypical autism, Asperger syndrome
	Arick 2003[388]	Children between the ages of 2 and 6 years (at baseline) who have been said to have a diagnosis of autism; details of criteria used not provided	67	67	100	–	–	2–6	Years	NR	NR	ASD
	Baghdadli 2012[339]	Age < 7 years, ICD-10 diagnosis of autism	280	280	100	4.9	1.3	–	Months	230	50	Childhood autism, atypical autism
	Bearss 2013[278]	Children were aged between 3 years and 6 years 11 months, and assessed to have autism based on ADOS and clinical observation	16	16	100	–	–	3–6	Years	16	0	AD, PDD-NOS
	Bennett 2008[296]	Children aged between 4 and 6 years	64	64	100	–	–	4–6	Years	57	7	Asperger syndrome, high-functioning autism
	Carlsson 2013[390]	Children aged from 4.5 to 6.5 years who were assessed to have autism based on DSM-IV criteria	198	119	60	–	–	4.5–6.5	Years	NR	NR	Autistic-like condition, Asperger syndrome, autistic traits

Social communication	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
	Cassidy 2008[348]	Parents of children aged < 5 years with ICD-10 diagnosis of ASD	104	104	100	–	–	2–4	Years	95	9	ASD
	Dawson 2010[321]	18–30 months, diagnosed by ADOS, ADI and DSM-IV	48	48	100	–	–	18–33	Months	37	11	AD, PDD-NOS
	Eikeseth 2009[410]	24–42 months with ICD-10 diagnosis of ASD	23	23	100	34.9	5.7	28–42	Months	17	6	Autism
	Eldevik 2012[414]	Children aged 2 to 6 who had autism diagnosis based on ICD-10 criteria and ADI-R	43	43	100	4.26	1.48	1–6	Years	33	10	Autism, PDD-NOS, Asperger syndrome
	Eriksson 2013[415]	Children aged 20–54 months. Criteria not stated	208	208	100	–	–	20–54	Months	176	32	ASD
	Gabriels 2007[416]	Children had a mean age of 31 months and had a clinical diagnosis of autistic disorder or PDD-NOS based on DSM-IV criteria	14	14	100	31	–	–	Months	10	4	AD, PDD-NOS
	Green 2010[253]	24–60 months, ADOS or ADI diagnosed	152	152	100	45	–	24–60	Months	138	14	Core autism
	Grindle 2012[417]	3- to 7-year-old children with autism	29	29	100	–	–	43–72	Months	25	4	Autism
	Hedvall 2013[418]	3.6- to 6.6-year-old children with ASD	190	168	88	55	0.8	42–76	Months	147	21	AD, PDD-NOS, Asperger syndrome
	Herring 2006[411]	Children were aged between 20 and 51 months who met the DSM-IV criteria for diagnosis	123	84	68	37.75	7.07	–	Months	75	9	AD, PDD-NOS
	Honey 2008[307]	24–48 months diagnosed by ICD-10 criteria	104	79	76	37.05	6.08	24–48	Months	65	14	ASD
	Hudry 2010[233]	24- to 59-month-old children with ADOS-G diagnosis	152	152	100	44.83	7.98	24–59	Months	138	14	Core autism
	Ben Itzchak 2011[320]	Children aged 15–35 months were included in the study	78	78	100	–	–	15–35	Months	71	7	Autism

Social communication	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
	Jasmin 2009[384]	Children aged 3–4 years who had a diagnosis of ASD based on DSM-IV criteria	35	35	100	–	–	3–4	Years	32	3	Autistic, PDD-NOS, Asperger syndrome
	Jonsdottir 2007[341]	Mean age was 41.43 months; diagnosis was based on ICD-10 criteria	41	41	100	41.43	9.06	22–59	Months	34	7	Childhood autism
	Klintwall 2012[419]	2 years and 3 months to 4 years and 11 months, with clinical diagnosis by paediatrician	21	21	100	3.6	–	2.25–4.9	Years	16	5	Autism
	Landa 2012[224]	22- to 33-month-old children with ASD or autism	48	48	100	27	2.8	22–33	Months	39	9	ASD
	Lerna 2012[325]	18–60 months old with diagnosis of autism and little or no functional language	18	18	100	–	–	18–60	Months	17	1	Autism
	Lloyd 2013[400]	12- to 36-month-old children with ASD	162	162	100	–	–	12–37	Months	140	22	ASD
	Luyster 2008[129]	Participants were aged 18–33 months and met ADI-R criteria for ASD diagnosis	164	164	100	–	–	18–33	Months	129	35	ASD
	Magiati 2007[308]	Children aged between 22 and 54 months who met ADI-R criteria for autism/ASD diagnosis	44	44	100	–	–	22–54	Months	39	5	Autism, ASD
	Magiati 2011[309]	Mean age of 3.4 years at start of the study	44	44	100	38.9	7.1	27–55	Months	39	5	Autism, ASD
	Mayo 2013[310]	45–72 months with DSM-IV-TR criteria	119	119	100	52.22	6.09	45–72	Months	99	20	AD, PDD-NOS
	McConkey 2010[349]	Children with ASD diagnosis (criteria not given, it was only stated as 'confirmed diagnosis of ASD from a specialist clinic') who had a mean age of 2.8 years at start of the study	62 (families)	61	98	–	–	< 4	Years	55	6	Autism

Social communication	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
	Munson 2006[420]	38–54 months with DSM-IV diagnosis of ASD	45	45	100	47.4	4.2	38–54	Months	38	7	AD, PDD-NOS
	Munson 2008[312]	24–66 months with ADI or ADOS diagnosis of ASD	456	456	100	43.4	8.7	24–66	Months	370	86	Autism, ASD
	O'Donnell 2012[386]	3–4 years old with DSM-IV diagnosis of ASD	42	42	100	45.5	–	36–59	Months	NR	NR	Autism, PDD-NOS
	Eapen 2013[357]	Mean age of 49.6 months	26	26	100	49.6	6.08	36–58	Months	21	5	AD
	Osborne 2008[350]	2.6–4 years old with GARS diagnosis of ASD	65	65	100	–	–	2.6–4	Years	59	6	ASD
	Osborne 2009[351]	2.6–4 years old with GARS diagnosis of ASD	65	65	100	3.4	0.75	2.6–4.0	Years	59	6	ASD
	Peters-Scheffer 2010[421]	3- to 6-year-old children with DSM-IV diagnosis of AD or PDD-NOS	34	34	100	53.5	5.52	42–62	Months	NR	NR	AD, PDD-NOS
	Poon 2012[401]	9–12 months (upon entering study) with ADOS, ADI or CARS diagnosis of ASD	29	29	100	4.46	1.49	–	Months	24	5	AD, PDD-NOS, Asperger syndrome
	Pry 2005[314]	21 months to 7 years with ICD-10 diagnosis of ASD	222	222	100	5	1.75	1.75–7	Years	180	42	Infantile autism
	Ray-Subramanian 2011[327]	23–39 months with DSM-IV or ICD-10 diagnosis of ASD	125	125	100	31	4.1	23–39	Months	108	17	Autism, AD, PDD-NOS
	Reed 2007[352]	2 years 6 months to 4 years old diagnosed with ASD	27	27	100	–	–	2.5–4.0	Years	27	0	ASD
	Reed 2007[353]	2 years 6 months to 4 years old with 'paediatrician' diagnosis of ASD	53	53	100	–	–	2.5–4.0	Years	Unclear	Unclear	ASD
	Reed 2012[354]	2.5–4 years with GARS diagnosis of ASD	66	66	100	40.2	5.6	–	Months	59	7	AD, PDD-NOS
	Remington 2007[358]	30–42 months of age with ADI diagnosis of ASD	44	44	100	37	4.2	30–42	Months	NR	NR	Autism or suspected autism
	Restall 1994[422]	3–6 years with DSM-III diagnosis of ASD	18	9	50	64.76	6.4	–	Months	8	1	Autism

Social communication	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
	Rickards 2009[423]	3–5 years, 35/59 diagnosed ASD by DSM-IV criteria	54	54	100	69.65	–	–	Months	43	11	ASD
	Roberts 2011[405]	2.2–5 years with DSM-IV diagnosis of ASD	95	95	100	–	–	26.3–60.3	Months	86	9	AD, ASD
	Rogers 2012[317]	14–24 months with ASD	98	98	100	21	–	–	Months	76	22	ASD
	Ruble 2008[424]	40–71 months with DSM-IV diagnosis of ASD	35	35	100	55.9	–	40.9–70.9	Months	30	5	Autism
	Salt 2002[372]	Preschool children in Scotland, (mean 42.36 months) with ICD-10 diagnosis of ASD	17	17	100	40.015	–	–	Months	14	3	Childhood autism
	Schertz 2013[402]	Mean age 24.6 and 27.5 months with ADOS diagnosis	23	23	100	26.05	–	–	Months	NR	NR	ASD
	Silva 2007[299]	3–6 years old with DSM-IV diagnosis of ASD	15	15	100	4.83	–	3–6	Years	13	2	AD
	Silva 2008[300]	3–6 years old with DSM-IV diagnosis of ASD	26	26	100	56.3	12.5	–	Months	21	5	Autism
	Smith 2000[413]	18–42 months with 'clinical' diagnosis of ASD	28	28	100	35.92	–	–	Months	23	5	Autism, PDD-NOS
	Smith 2010[359]	All < 6 years with ADOS/ADI/DSM-IV diagnosis of ASD	53	53	100	50.1	10	–	Months	47	6	Autism
	Stahmer 2004[355]	0–3 years with DSM-IV diagnosis	20	20	100	29.6	–	22–33	Months	16	4	AD, PDD-NOS
	Stone 1999[346]	23–35 months with DSM-III or DSM-IV diagnosis of ASD	60	30	50	31.3	3.3	23–35	Months	25	5	Autism
	Strauss 2012[329]	26–81 months with DSM-IV diagnosis of ASD	44	44	100	–	–	26–81	Months	41	3	Autism, PDD-NOS
	Szatmari 2000[302]	4- to 6-year-old children (upon entering study) diagnosed by ADI	134	68	51	66.8	–	–	Months	59	7	Autism, Asperger syndrome

Social communication	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
	Tonge 2012[425]	Children were aged 2.5–5 years and diagnosis was made using a combination of medical reviews, ADI-R and CARS	107	107	100	–	–	2.5–5.0	Years	90	17	AD
	Toth 2006[284]	34–52 months with ADI-diagnosis of ASD	60	60	100	43.6	4.3	34–52	Months	51	9	AD, PDD-NOS
	VanMeter 1997[426]	Mean ages ranged from 2.9 (SD = 0.77) to 5.7 (SD = 1.31) years meeting DSM-III criteria for ASD	143	57	40	–	–	5.2–6.0	Years	54	3	AD
	Ventola 2007[332]	16–32 months old with M-CHAT diagnosis of ASD	195	195	100	–	–	16–32	Months	152	43	ASD
	Werner 2005[316]	12–57 months with DSM-IV diagnosis of ASD	145	72	50	43.5	4.3	–	Months	60	12	AD, PDD-NOS
	Zachor 2010[335]	15- to 35-month-old children who met DSM-IV criteria	71	71	100	25.55	4.25	15–35	Months	71	7	Autism
Parent Survey[a]	Arick 2003[388]	Children between the ages of 2 and 6 years (at baseline) who have been said to have a diagnosis of autism; details of criteria used not provided	67	67	100	–	–	2–6	Years	NR	NR	ASD
Caregiver–child interaction[b]	Kasari 2006[368]	Children were aged 3 to 4 years and had a diagnosis of autism based on ADI-R and ADOS criteria	58	58	100	–	–	3–4	Years	46	12	Autism
Classroom and playground behaviour observations[b]	Escalona 2001[271]	Children were aged 3 to 6 years based on DSM III – R	20	20	100	5.2	1.8	3–6	Years	12	8	Autism

Social communication	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
Coding of initiation of joint attention[b]	Ingersoll 2012[286]	27 children between 27 and 47 months old who met DSM-IV-TR criteria	29	29	100	37.9	–	22–47	Months	24	5	AD
Examiner Ratings of Social Engagement[b]	Ozonoff 2010[313]	Assessed between 6 and 36 months, diagnosed using ADOS	50	25	50	–	–	6	Months	19	6	AD, PDD-NOS
Parent–child interaction[b]	Green 2010[253]	24–60 months, ADOS or ADI diagnosed	152	152	100	45	–	24–60	Months	138	14	Core autism
Parent–child interaction[b]	Aldred 2012[319]	Children aged 2–5 years assessed using ADOS and ADI-R	28	28	100	–	–	2–5	Years	25	3	Autism
Preschool teacher–child play[b]	Kaale 2012[294]	Children aged 29–60 months who had a diagnosis of autistic disorder based on ICD-10 criteria	61	61	100	–	–	24–60	Months	48	13	Autism
Unstructured free play with examiner[b]	Lerna 2012[325]	18–60 months old with diagnosis of autism and little or no functional language	18	18	100	–	–	18–60	Months	17	1	Autism
Video coding procedures[b]	Colgan 2006[379]	Children aged 8–12 months with diagnosis of autism based on DSM-III-R or DSM-IV criteria	35	21	60	–	–	0–2	Years	17	4	AD
Video recording of child in classroom activities[b]	Ingersoll 2001[380]	Children ages 26 to 41 months who met DSM-IV criteria for ASD	9	6	67	–	–	26–41	Months	NR	NR	Autism, PDD-NOS

AD, autistic disorder; DSM-IV-TR, *Diagnostic and Statistical Manual of Mental Disorders*-Fourth Edition-Text Revision; F, female; M, male; NR, not reported; SD, standard deviation.
a Tools developed ad hoc.
b Observational coding.

Social functioning	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
Autism Diagnostic Interview (ADI)	Ben Itzchak 2008[149]	Children aged 19–35 months with autism diagnosis based on DSM-IV criteria	81	44	54	–	–	16–35	Months	43	1	Autism
Autism Diagnostic Interview-Revised (ADI-R)	Bennett 2012[304]	Children with ASD aged 2–4 years old	214	178	83	–	–	2–4	Years	181	33	AD, Asperger syndrome, PDD-NOS
	Brian 2008[305]	Children had no diagnosis of ASD but were followed up to 36 months at which point some were diagnosed of ASD	228	35	15	–	–	6–12	Months	NR	NR	Autism, Asperger syndrome, PDD-NOS
	Feldman 2012[104]	Children who aged between 1 and 24 months who were 'at risk' for autism (they had a sibling with a diagnosis of ASD, Asperger syndrome or PDD-NOS)	108 (parents)	108	100	8	5	–	Months	74	34	AD, PDD-NOS, Asperger syndrome and high-functioning autism
	Hambly 2012[306]	Children with ASDs from bilingual and monolingual homes	75	75	100	–	–	36–78	Months	60	15	Autism, ASD, Asperger syndrome, PDD-NOS
Autism Diagnostic Interview (ADI)	Honey 2008[307]	24–48 months diagnosed by ICD-10 criteria	104	79	76	37.05	6.08	24–48	Months	65	14	ASD
Autism Diagnostic Interview-Revised (ADI-R)	Magiati 2007[308]	Children aged between 22 and 54 months who met ADI-R criteria for autism/ASD diagnosis	44	44	100	–	–	22–54	Months	39	5	Autism, ASD
	Magiati 2011[309]	Mean age of 3.4 years at start of the study	44	44	100	38.9	7.1	27–55	Months	39	5	Autism, ASD
	Mayo 2013[310]	45–72 months with DSM-IV-TR criteria	119	119	100	52.22	6.09	45–72	Months	99	20	AD, PDD-NOS
	Mooney 2006[311]	22–51 months with DSM-IV diagnosis of ASD	55	40	73	36.95	7.26	22–51	Months	34	6	AD
	Munson 2008[312]	24–66 months with ADI or ADOS diagnosis of ASD	456	456	100	43.4	8.7	24–66	Months	370	86	Autism, ASD
	Ozonoff 2010[313]	Assessed between 6 and 36 months, diagnosed using ADOS	50	25	50	–	–	6	Months	19	6	AD, PDD-NOS

Social functioning	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
Autism Diagnostic Interview (ADI)	Pry 2005[314]	21 months to 7 years with ICD-10 diagnosis of ASD	222	222	100	5	1.75	1.75–7	Years	180	42	Infantile autism
Autism Diagnostic Interview-Revised (ADI-R)	Richler 2007[315]	Up to 3 years old, with 'clinical' diagnosis of ASD	279	192	69	–	–	0–37	Months	162	30	Autism, PDD-NOS
Autism Diagnostic Interview (ADI)	Werner 2005[316]	12–57 months with DSM-IV diagnosis of ASD	145	72	50	43.5	4.3	–	Months	60	12	AD, PDD-NOS
Child Behavior Scale (CBS)	Jahromi 2013[431]	20 TD and 20 children with high-functioning autism	40	20	50	58.95	11.5	–	Months	36	4	High-functioning autism
	Meek 2012[435]	2.75–6.5 years with ADI diagnosis of ASD	40	20	50	58.95	11.5	–	Months	36	4	Autism
Nisonger Child Behavior Rating Scales	Remington 2007[358]	30–42 months of age with ADI diagnosis of ASD	44	44	100	37	4.2	30–42	Months	NR	NR	Autism or suspected autism
Social Behavior Rating Scale	Vorgraft 2007[347]	38–49-month-old children with DSM-IV diagnosis of PDD-NOS	23	23	100	42.8	–	38–19	Months	15	8	Autism, PDD-NOS
Vineland Adaptive Behavior Scales-Classroom version (VABS-Classroom)	Goin-Kochel 2007[427]	Children were aged between 29.6–61.4 months; diagnosis was based on ADOS criteria	29	29	100	45.7	9.6	29.6–61.4	Months	27	2	Autism, PDD-NOS
Vineland Adaptive Behavior Scales (VABS)	Aldred 2004[318]	2 years to 5 years 11 months with ADI diagnosis	28	28	100	–	–	24–71	Months	25	3	AD or 'classical autism'
	Anan 2008[396]	25 to 68 months old children who met the diagnosis of ASD based on DSM-IV criteria	72	72	100	–	–	25–68	Months	61	11	AD, PDD-NOS
	Andersson 2013[409]	Children aged 1.8 to 3.9 years who met DSM-IV criteria	40	37	93	–	–	1.8–3.9	Years	18	19	AD, ASD, atypical autism, Asperger syndrome
	Arick 2003[388]	Children between the ages of 2 and 6 years (at baseline) who have been said to have a diagnosis of autism; details of criteria used not provided	67	67	100	–	–	2–6	Years	NR	NR	ASD

Social functioning	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
	Baghdadli 2012[339]	Age < 7 years, ICD-10 diagnosis of autism	280	280	100	4.9	1.3	–	Months	230	50	Childhood autism, atypical autism
	Bearss 2013[278]	Children were aged between 3 years and 6 years 11 months, and assessed to have autism based on ADOS and clinical observation	16	16	100	–	–	3–6	Years	16	0	AD, PDD-NOS
	Bennett 2008[296]	Children aged between 4 and 6 years	64	64	100	–	–	4–6	Years	57	7	Asperger syndrome, high-functioning autism
	Carlsson 2013[390]	Children aged from 4.5 to 6.5 years who were assessed to have autism based on DSM-IV criteria	198	119	60	–	–	4.5–6.5	Years	NR	NR	Autistic-like condition, Asperger syndrome, autistic traits
	Cassidy 2008[348]	Parents of children aged < 5 years with ICD-10 diagnosis of ASD	104	104	100	–	–	2–4	Years	95	9	ASD
	Dawson 2010[321]	18–30 months, diagnosed by ADOS, ADI and DSM-IV	48	48	100	–	–	18–33	Months	37	11	AD, PDD-NOS
	Eikeseth 2009[410]	24–42 months with ICD-10 diagnosis of ASD	23	23	100	34.9	5.7	28–42	Months	17	6	Autism
	Eldevik 2012[414]	Children aged 2 to 6 who had autism diagnosis based on ICD-10 criteria and ADI-R	43	43	100	4.26	1.48	1–6	Years	33	10	Autism, PDD-NOS, Asperger
	Eriksson 2013[415]	Children aged 20–54 months. Criteria not stated	208	208	100	–	–	20–54	Months	176	32	ASD
	Gabriels 2007[416]	Children had a mean age of 31 months and had a clinical diagnosis of autistic disorder or PDD-NOS based on DSM-IV criteria	14	14	100	31	–	–	Months	10	4	AD, PDD-NOS
	Green 2010[253]	24–60 months, ADOS or ADI diagnosed	152	152	100	45	–	24–60	Months	138	14	Core autism
	Grindle 2012[417]	3- to 7-year-old children with autism	29	29	100	–	–	43–72	Months	25	4	Autism

Social functioning	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
	Hedvall 2013[418]	3.6- to 6.6-year-old children with ASD	190	168	88	55	0.8	42–76	Months	147	21	AD, PDD-NOS, Asperger syndrome
	Herring 2006[411]	Children were aged between 20 and 51 months who met the DSM-IV criteria for diagnosis	123	84	68	37.75	7.07	–	Months	75	9	AD, PDD-NOS
	Honey 2008[307]	24–48 months diagnosed by ICD-10 criteria	104	79	76	37.05	6.08	24–48	Months	65	14	ASD
	Hudry 2010[233]	24- to 59-month-old children with ADOS-G diagnosis	152	152	100	44.83	7.98	24–59	Months	138	14	Core autism
	Ben Itzchak 2011[320]	Children aged 15–35 months were included in the study	78	78	100	–	–	15–35	Months	71	7	Autism
	Jasmin 2009[384]	Children aged 3–4 years who had a diagnosis of ASD based on DSM-IV criteria	35	35	100	–	–	3–4	Years	32	3	Autistic, PDD-NOS, Asperger syndrome
	Jonsdottir 2007[341]	Mean age was 41.43 months; diagnosis was based on ICD-10 criteria	41	41	100	41.43	9.06	22–59	Months	34	7	Childhood autism
	Klintwall 2012[419]	2 years and 3 months to 4 years and 11 months, with clinical diagnosis by paediatrician	21	21	100	3.6	–	2.25–4.9	Years	16	5	Autism
	Landa 2012[224]	22- to 33-month-old children with ASD or autism	48	48	100	27	2.8	22–33	Months	39	9	ASD
	Lerna 2012[325]	18–60 months old with diagnosis of autism and little or no functional language	18	18	100	–	–	18–60	Months	17	1	Autism
	Lloyd 2013[400]	12- to 36-month-old children with ASD	162	162	100	–	–	12–37	Months	140	22	ASD
	Luyster 2008[129]	Participants were aged 18–33 months and met ADI-R criteria for ASD diagnosis	164	164	100	–	–	18–33	Months	129	35	ASD

Social functioning	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
	Magiati 2007[308]	Children aged between 22 and 54 months who met ADI-R criteria for autism/ASD diagnosis	44	44	100	–	–	22–54	Months	39	5	Autism, ASD
	Magiati 2011[309]	Mean age of 3.4 years at start of the study	44	44	100	38.9	7.1	27–55	Months	39	5	Autism, ASD
	Mayo 2013[310]	45–72 months with DSM-IV-TR criteria	119	119	100	52.22	6.09	45–72	Months	99	20	AD, PDD-NOS
	McConkey 2010[349]	Children with ASD diagnosis (criteria not given, it was only stated as 'confirmed diagnosis of ASD from a specialist clinic') who had a mean age of 2.8 years at start of the study	62 (families)	61	98	–	–	< 4	Years	55	6	Autism
	Munson 2006[420]	38–54 months with DSM-IV diagnosis of ASD	45	45	100	47.4	4.2	38–54	Months	38	7	AD, PDD-NOS
	Munson 2008[312]	24–66 months with ADI or ADOS diagnosis of ASD	456	456	100	43.4	8.7	24–66	Months	370	86	Autism, ASD
	O'Donnell 2012[386]	3–4 years old with DSM-IV diagnosis of ASD	42	42	100	45.5	–	36–59	Months	NR	NR	Autism, PDD-NOS
	Eapen 2013[357]	Mean age of 49.6 months	26	26	100	49.6	6.08	36–58	Months	21	5	AD
	Osborne 2008[350]	2.6–4 years old with GARS diagnosis of ASD	65	65	100	–	–	2.6–4.0	Years	59	6	ASD
	Osborne 2009[351]	2.6–4 years old with GARS diagnosis of ASD	65	65	100	3.4	0.75	2.6–4.0	Years	59	6	ASD
	Peters-Scheffer 2010[421]	3- to 6-year-old children with DSM-IV diagnosis of AD or PDD-NOS	34	34	100	53.5	5.52	42–62	Months	NR	NR	AD, PDD-NOS
	Poon 2012[401]	9–12 months (upon entering study) with ADOS, ADI or CARS diagnosis of ASD	29	29	100	4.46	1.49	–	Months	24	5	AD, PDD-NOS, Asperger syndrome
	Pry 2005[314]	21 months to 7 years with ICD-10 diagnosis of ASD	222	222	100	5	1.75	1.75–7.00	Years	180	42	Infantile autism

Social functioning	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
	Ray-Subramanian 2011[327]	23–39 months with DSM-IV or ICD-10 diagnosis of ASD	125	125	100	31	4.1	23–39	Months	108	17	Autism, AD, PDD-NOS
	Reed 2007[352]	2 years 6 months to 4 years old diagnosed with ASD	27	27	100	–	–	2.5–4.0	Years	27	0	ASD
	Reed 2007[353]	2 years 6 months to 4 years old with 'paediatrician' diagnosis of ASD	53	53	100	–	–	2.5–4.0	Years	Unclear	Unclear	ASD
	Reed 2012[354]	2.5–4 years with GARS diagnosis of ASD	66	66	100	40.2	5.6	–	Months	59	7	AD, PDD-NOS
	Remington 2007[358]	30–42 months of age with ADI diagnosis of ASD	44	44	100	37	4.2	30–42	Months	NR	NR	Autism or suspected autism
	Restall 1994[422]	3–6 years with DSM-III diagnosis of ASD	18	9	50	64.76	6.4	–	Months	8	1	Autism
	Rickards 2009[423]	3–5 years, 35/59 diagnosed ASD by DSM-IV criteria	54	54	100	69.65	–	–	Months	43	11	ASD
	Roberts 2011[405]	2.2–5 years with DSM-IV diagnosis of ASD	95	95	100	–	–	26.3–60.3	Months	86	9	AD, ASD
	Rogers 2012[317]	14–24 months with ASD	98	98	100	21	–	–	Months	76	22	ASD
	Ruble 2008[424]	40–71 months with DSM-IV diagnosis of ASD	35	35	100	55.9	–	40.9–70.9	Months	30	5	Autism
	Salt 2002[372]	Preschool children in Scotland, (mean 42.36 months) with ICD-10 diagnosis of ASD	17	17	100	40.015	–	–	Months	14	3	Childhood autism
	Schertz 2013[402]	Mean age 24.6 and 27.5 months with ADOS diagnosis	23	23	100	26.05	–	–	Months	NR	NR	ASD
	Silva 2007[299]	3–6 years old with DSM-IV diagnosis of ASD	15	15	100	4.83	–	3–6	Years	13	2	AD
	Silva 2008[300]	3–6 years old with DSM-IV diagnosis of ASD	26	26	100	56.3	12.5	–	Months	21	5	Autism

Social functioning	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
	Smith 2000[413]	18–42 months with 'clinical' diagnosis of ASD	28	28	100	35.92	–	–	Months	23	5	Autism, PDD-NOS
	Smith 2010[359]	All < 6 years with ADOS/ADI/DSM-IV diagnosis of ASD	53	53	100	50.1	10	–	Months	47	6	Autism
	Stahmer 2004[355]	0–3 years with DSM-IV diagnosis	20	20	100	29.6	–	22–33	Months	16	4	AD, PDD-NOS
	Stone 1999[346]	23–35 months with DSM-III or DSM-IV diagnosis of ASD	60	30	50	31.3	3.3	23–35	Months	25	5	Autism
	Strauss 2012[329]	26–81 months with DSM-IV diagnosis of ASD	44	44	100	–	–	26–81	Months	41	3	Autism, PDD-NOS
	Szatmari 2000[302]	4- to 6-year-old children (upon entering study) diagnosed by ADI	134	68	51	66.8	–	–	Months	59	7	Autism, Asperger syndrome
	Tonge 2012[425]	Children were aged 2.5–5 years and diagnosis was made using a combination of medical reviews, ADI-R and CARS	107	107	100	–	–	2.5–5.0	Years	90	17	AD
	Toth 2006[284]	34–52 months with ADI-diagnosis of ASD	60	60	100	43.6	4.3	34–52	Months	51	9	AD, PDD-NOS
	VanMeter 1997[426]	Mean ages ranged from 2.9 (SD = 0.77) to 5.7 (SD = 1.31) years meeting DSM-III criteria for ASD	143	57	40	–	–	5.2–6.0	Years	54	3	AD
	Ventola 2007[332]	16–32 months old with M-CHAT diagnosis of ASD	195	195	100	–	–	16–32	Months	152	43	ASD
	Werner 2005[316]	12–57 months with DSM-IV diagnosis of ASD	145	72	50	43.5	4.3	–	Months	60	12	AD, PDD-NOS
	Zachor 2010[335]	15- to 35-month-old children who met DSM-IV criteria	71	71	100	25.55	4.25	15–35	Months	71	7	Autism

Social functioning	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
Vineland Social Maturity Scale, Indian adaptation[a]	Malhi 2011[342]	Children were ≤ 3 years at start of the study and had an ASD diagnosis based on DSM-IV criteria	77	77	100	–	–	0–3	Years	64	13	AD, PDD-NOS
Parent Survey[b]	Arick 2003[388]	Children between the ages of 2 and 6 years (at baseline) who have been said to have a diagnosis of autism; details of criteria used not provided	67	67	100	–	–	2–6	Years	NR	NR	ASD
Classroom and playground behaviour observations[c]	Escalona 2001[271]	Children were aged 3 to 6 years based on DSM III – R	20	20	100	5.2	1.8	3–6	Years	12	8	Autism
Coded observation of social behaviour[c]	Meirsschaut 2011[442]	21–56 months meeting ADOS criteria for ASD	42	21	50	36.94	–	21–56	Months	18	3	Autism, ASD
Video recording of child in classroom activities[c]	Ingersoll 2001[380]	Children ages 26 to 41 months who met DSM-IV criteria for ASD	9	6	67	–	–	26–41	Months	NR	NR	Autism, PDD-NOS

AD, autistic disorder; DSM-IV-TR, *Diagnostic and Statistical Manual of Mental Disorders*-Fourth Edition-Text Revision; F, female; M, male; NR, not reported; SD, standard deviation; TD, typically developing.
a Non-UK.
b Tools developed ad hoc.
c Observational coding.

Play	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
Autism Diagnostic Observation Scale-Toddler Module (ADOS-T)	Rogers 2012[317]	14–24 months with ASD	98	98	100	21	–	–	Months	76	22	ASD
Autism Diagnostic Observation Schedule (ADOS)	Aldred 2004[318]	2 years to 5 years 11 months with ADI diagnosis	28	28	100	–	–	24–71	Months	25	3	AD or 'classical autism'
	Aldred 2012[319]	Children aged 2–5 years assessed using ADOS and ADI-R	28	28	100	–	–	2–5	Years	25	3	Autism
	Ben Itzchak 2008[149]	Children aged 19–35 months with autism diagnosis based on DSM-IV criteria	81	44	54	–	–	16–35	Months	43	1	Autism
	Ben Itzchak 2011[320]	Children aged 15–35 months were included in the study	78	78	100	–	–	15–35	Months	71	7	Autism
	Bennett 2012[304]	Children with ASD aged 2–4 years old	214	178	83	–	–	2–4	Years	181	33	AD, Asperger syndrome, PDD-NOS
	Brian 2008[305]	Children had no diagnosis of ASD but were followed up to 36 months at which point some were diagnosed of ASD	228	35	15	–	–	6–12	Months	NR	NR	Autism, Asperger syndrome, PDD-NOS
	Dawson 2010[321]	18–30 months, diagnosed by ADOS, ADI and DSM-IV	48	48	100	–	–	18–30	Months	37	11	AD, PDD-NOS
	Gotham 2012[322]	Best-estimate clinical diagnosis of ASD at one or more time points	345	345	100	3.3	1.4	–	Years	282	63	Autism, PDD-NOS
Autism Diagnostic Observation Schedule-Generic (ADOS-G)	Green 2010[253]	24–60 months, ADOS or ADI diagnosed	152	152	100	45	–	24–60	Months	138	14	Core autism
	Hartley 2009[323]	Children aged 1.5 to 3.9 years based on DSM-IV-TR criteria and ADOS-G classification	499	199	40	–	–	18–47	Months	157	42	AD, PDD-NOS
Autism Diagnostic Observation Schedule (ADOS)	Landa 2012[224]	22- to 33-month-old children with ASD or autism	48	48	100	27	2.8	22–33	Months	39	9	ASD
	Lerna 2012[325]	18–60 months old with diagnosis of autism and little or no functional language	18	18	100	–	–	18–60	Months	17	1	Autism

Play	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
	Luyster 2008[129]	Participants were aged 18–33 months and met ADI-R criteria for ASD diagnosis	164	164	100	–	–	18–33	Months	129	35	ASD
Autism Diagnostic Observation Schedule-Generic (ADOS-G)	Munson 2008[312]	24–66 months with ADI or ADOS diagnosis of ASD	456	456	100	43.4	8.7	24–66	Months	370	86	Autism, ASD
Autism Diagnostic Observation Schedule (ADOS)	Oosterling 2010[326]	12–42 months old with 'clinical' diagnosis of ASD	80	80	100	34.8	–	–	Months	62	18	Autism, PDD-NOS
	Ray-Subramanian 2011[327]	23–39 months with DSM-IV or ICD-10 diagnosis of ASD	125	125	100	31	4.1	23–39	Months	108	17	Autism, AD, PDD-NOS
	Ray-Subramanian 2012[328]	2–3 years with DSM-IV diagnosis	115	115	100	31	4.1	–	Months	97	18	Autism, AD, PDD-NOS
	Strauss 2012[329]	26–81 months with DSM-IV diagnosis of ASD	44	44	100	–	–	26–81	Months	41	3	Autism, PDD-NOS
	Sullivan 2007[330]	Tested at 14–24 months and 30–36 months who met DSM-IV criteria for diagnosis	51	16	31	–	–	14–36	Months	14	2	Autism, PDD-NOS
Autism Diagnostic Observation Schedule-Generic (ADOS-G)	Tek 2012[331]	16–38 months with ADOS diagnosis	84	84	100	27	–	16–38	Months	NR	NR	ASD
	Ventola 2007[332]	16–32 months old with M-CHAT diagnosis of ASD	195	195	100	–	–	16–32	Months	152	43	ASD
Autism Diagnostic Observation Schedule (ADOS)	Werner 2005[316]	12–57 months with DSM-IV diagnosis of ASD	145	72	50	43.5	4.3	–	Months	60	12	AD, PDD-NOS
	Wong 2010[333]	17–36 months children diagnosed by DSM-IV, ADI and ADOS	17	17	100	–	–	17–36	Months	16	1	–
	Zachor 2006[334]	Participants were aged 23–33 months and met DSM-IV criteria for autism diagnosis	39	39	100	–	–	23–33	Months	37	2	Autism
	Zachor 2010[335]	15- to 35-month-old children who met DSM-IV criteria	71	71	100	25.55	4.25	15–35	Months	71	7	Autism

Play	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
Communication and Symbolic Behavior Scales-Developmental Profile (Caregiver Questionnaire) (CSBS-DP CQ; Wetherby and Prizant 2002[127])	Tek 2012[331]	16–38 months with ADOS diagnosis	84	84	100	27	–	16–38	Months	NR	NR	ASD
Developmental Play Assessment (DPA) – Instrument Sequence of Categories	Freeman 2013[443]	18- to 55-month-old children, 50 met DSM-IV criteria	32 (parent–child dyads)	16	50	49.5	11.8	–	Months	12	4	Autism
Structured Play Assessment	Freeman 2013[443]	18- to 55-month-old children, 50 met DSM-IV criteria	32 (parent–child dyads)	16	50	49.5	11.8	–	Months	12	4	Autism
	Goods 2013[366]	36- to 60-month-old children with autism (ADOS assessment)	15	15	100	51.9	–	–	Months	NR	NR	Autism
	Kasari 2006[368]	Children were aged 3 to 4 years and had a diagnosis of autism based on ADI-R and ADOS criteria	58	58	100	–	–	3–4	Years	46	12	Autism
Symbolic Play Test	Wong 2010[333]	17–36 months children diagnosed by DSM-IV, ADI and ADOS	17	17	100	–	–	17–36	Months	16	1	–
	Salt 2002[372]	Preschool children in Scotland, (mean 42.36 months) with ICD-10 diagnosis of ASD	17	17	100	40.02	–	–	Months	14	3	Childhood autism
	Magiati 2007[308]	Children aged between 22 and 54 months who met ADI-R criteria for autism/ASD diagnosis	44	44	100	–	–	22–54	Months	39	5	Autism, ASD

Play	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
Test of Pretend Play (ToPP)	Magiati 2007[308]	Children aged between 22 and 54 months who met ADI-R criteria for autism/ASD diagnosis	44	44	100	–	–	22–54	Months	39	5	Autism, ASD
	Dereu 2012[365]	Children aged 2–4 years; ADOS was used for diagnosis	17	9	53	–	–	17–39	Months	6	3	ASD
Preschool Play Scale[a]	Restall 1994[422]	3–6 years with DSM-III diagnosis of ASD	18	9	50	64.76	6.4	–	Months	8	1	Autism
Caregiver–child interaction[b]	Kasari 2006[368]	Children were aged 3 to 4 years and had a diagnosis of autism based on ADI-R and ADOS criteria	58	58	100	–	–	3–4	Years	46	12	Autism
Coded observation of social behaviour[b]	Meirsschaut 2011[442]	21–56 months meeting ADOS criteria for ASD	42	21	50	36.94	–	21–56	Months	18	3	Autism, ASD
Coding of videos[b]	Flippin 2011[406]	Children aged 40–69 months with autism diagnosis based on ADOS	16	16	100	53.3	9.6	40–69	Months	12	4	ASD
Free play assessment[b]	Christensen 2010[444]	18 months upon entering – 17/77 subsequently diagnosed as ASD using ADOS	77	17	22	33.95	4.69	18–40	Months	14	3	ASD
Parent–child free play[b]	Freeman 2013[443]	18- to 55-month-old children, 50 met DSM-IV criteria	32 (parent–child dyads)	16	50	49.5	11.8	–	Months	12	4	Autism

AD, autistic disorder; DSM-IV-TR, *Diagnostic and Statistical Manual of Mental Disorders*-Fourth Edition-Text Revision; F, female; M, male; NR, not reported; SD, standard deviation.
a Pre-1995.
b Observational coding.

Behaviour	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
Aberrant Behavior Checklist (ABC)	Baghdadli 2012[339]	Age < 7 years, ICD-10 diagnosis of autism	280	280	100	4.9	1.3	–	Months	230	50	Childhood autism, atypical autism
	Bearss 2013[278]	Children were aged between 3 years and 6 years 11 months, and assessed to have autism based on ADOS and clinical observation	16	16	100	–	–	3–6	Years	16	0	AD, PDD-NOS
	O'Donnell 2012[386]	3–4 years old with DSM-IV diagnosis of ASD	42	42	100	45.5	–	36–59	Months	NR	NR	Autism, PDD-NOS
	Werner 2005[316]	12–57 months with DSM-IV diagnosis of ASD	145	72	50	43.5	4.3	–	Months	60	12	AD, PDD-NOS
Baby and Infant Screen for Children with aUtIsm Traits (BISCUIT-Part 3)	Rojahn 2009[445]	17–37 months with DSM-IV diagnosis of ASD	762	312	41	27.29	4.73	17–37	Months	227	85	Autism, PDD-NOS
Behavior Assessment System for Children-Second Edition (BASC-2)	Hill-Chapman 2013[434]	Parents of children with ASD	56 (parents)	56	100	3.98	1.31	–	Years	N/A	N/A	AD, PDD-NOS, Asperger syndrome
Behavior Screening Questionnaire	Rickards 2009[423]	3–5 years, 35/59 diagnosed ASD by DSM-IV criteria	54	54	100	69.65	–	–	Months	43	11	ASD
Child Behavior Checklist (CBCL)	Baker 2010[397]	33 'at-risk' children, entered study between ages of 2–18 months, assessed at 18, 24, 30 and 36 months. [24 of the 33 children had a sibling with ASD or PDD (DSM-IV diagnosed)]	33	12	36	18	–	–	Months	NR	NR	ASD
	Hartley 2009[323]	Children aged 1.5 to 3.9 years based on DSM-IV-TR criteria and ADOS-G classification	499	199	40	–	–	18–48	Months	157	42	AD, PDD-NOS

Behaviour	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
	Peters-Scheffer 2010[421]	3- to 6-year-old children with DSM-IV diagnosis of AD or PDD-NOS	34	34	100	53.5	5.52	42–62	Months	NR	NR	AD, PDD-NOS
	Smith 2000[413]	18–42 months with 'clinical' diagnosis of ASD	28	28	100	35.92	–	–	Months	23	5	Autism, PDD-NOS
	Smith 2010[359]	All < 6 years with ADOS/ADI/ DSM-IV diagnosis of ASD	53	53	100	50.1	10	–	Months	47	6	Autism
	Taylor 2012[436]	Mothers of ASD children aged mean 3.72 years (SD = 1.82) and 4.18 (SD = 2.65) at diagnosis	75 (mothers)	75	100	3.72	18.2	–	Months	NR	NR	ASD
Child Behavior Scale (CBS)	Jahromi 2013[431]	20 TD and 20 children with high-functioning autism	40	20	50	58.95	11.5	–	Months	36	4	High-functioning autism
	Meek 2012[435]	2.75–6.5 years with ADI diagnosis of ASD	40	20	50	58.95	11.5	–	Months	36	4	Autism
Conners Rating Scales-Revised	Escalona 2001[271]	Children were aged 3 to 6 years based on DSM-III-R	20	20	100	5.2	1.8	3–6	Years	12	8	Autism
	Osborne 2009[351]	2.6–4 years old with GARS diagnosis of ASD	65	65	100	3.4	0.75	2.6–4.0	Years	59	6	ASD
	Reed 2007[353]	2 years 6 months to 4 years old with 'paediatrician' diagnosis of ASD	53	53	100	–	–	2.5–4.0	Years	NR	NR	ASD
	Reed 2013[437]	–	52	52	100	44.4	7.9	36.77	Months	46	6	Childhood autism, PDD-NOS
Developmental Behaviour Checklist	Herring 2006[411]	Children were aged between 20 and 51 months who met the DSM-IV criteria for diagnosis	123	84	68	37.75	7.07	–	Months	75	9	AD, PDD-NOS
	Mooney 2006[311]	22–51 months with DSM-IV diagnosis of ASD	55	40	73	36.95	7.26	22–51	Months	34	6	AD

Behaviour	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
	Remington 2007[358]	30–42 months of age with ADI diagnosis of ASD	44	44	100	37	4.2	30–42	Months	NR	NR	Autism or suspected autism
	Roberts 2011[405]	2.2–5 years with DSM-IV diagnosis of ASD	95	95	100	–	–	26.3–60.3	Months	86	9	AD, ASD
	Tonge 2012[425]	Children were aged 2.5–5 years and diagnosis was made using a combination of medical reviews, ADI-R and CARS	107	107	100	–	–	2.5–5.0	Years	90	17	AD
Home Situations Questionnaire (HSQ)	Bearss 2013[278]	Children were aged between 3 years and 6 years 11 months, and assessed to have autism based on ADOS and clinical observation	16	16	100	–	–	3–6	Years	16	0	AD, PDD-NOS
Nisonger Child Behavior Rating Scales	Remington 2007[358]	30–42 months of age with ADI diagnosis of ASD	44	44	100	37	4.2	30–42	Months	NR	NR	Autism or suspected autism
Parent Target Problems	Bearss 2013[278]	Children were aged between 3 years and 6 years 11 months, and assessed to have autism based on ADOS and clinical observation	16	16	100	–	–	3–6	Years	16	0	AD, PDD-NOS
Pre-School Behavior Checklist	Rickards 2009[423]	3–5 years, 35/59 diagnosed ASD by DSM-IV criteria	54	54	100	69.65	–	–	Months	43	11	ASD

Behaviour	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
Behaviour Style Questionnaire – Chinese version (Xu 1979)[a]	Chuang 2012[383]	Children were aged 48–84 months and had DSM-IV-TR diagnosis of autism	111	67	60	–	–	48–84	Months	57	10	Autism
Coded Observation of Child Behaviour problems[b]	Robbins 1992[446]	24–60 months upon entry, diagnosed by 'outside agency'	15	15	100	–	–	24–60	Months	14	1	Autism or autism characteristics
Functional Behaviour Assessment Interview (O'Neill *et al.* 1997)[c]	Reese 2005[447]	24–60 months with DSM-IV criteria of ASD	46	23	50	45.1	13.8	24–60	Months	17	6	Autism
Parent Survey[c]	Arick 2003[388]	Children between the ages of 2 and 6 years (at baseline) who have been said to have a diagnosis of autism; details of criteria used not provided	67	67	100	–	–	2–6	Years	NR	NR	ASD
Video coding procedures (for children and parents)[d]	Bryce 2013[448]	58.95 months (SD = 11.50), ADI-R was used to confirm diagnosis	40	20	50	58.95	11.5	–	Months	NR	NR	Autism

AD, autistic disorder; DSM-IV-TR, *Diagnostic and Statistical Manual of Mental Disorders*-Fourth Edition-Text Revision; F, female; M, male; N/A, not available; NR, not reported; SD, standard deviation; TD, typically developing.

a Non-UK.

b Pre-1995.

c Tools developed ad hoc.

d Observational coding.

Habit problems	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
Child Behavior Checklist (CBCL)	Smith 2000[413]	18–42 months with 'clinical' diagnosis of ASD	28	28	100	35.92	–	–	Months	23	5	Autism, PDD-NOS
	Baker 2010[397]	33 'at-risk' children, entered study between ages of 2–18 months, assessed at 18, 24, 30 and 36 months. [24 of the 33 children had a sibling with ASD or PDD (DSM-IV diagnosed)]	33	12	36	18	–	–	Months	NR	NR	ASD
	Peters-Scheffer 2010[421]	3- to 6-year-old children with DSM-IV diagnosis of AD or PDD-NOS	34	34	100	53.5	5.52	42–62	Months	NR	NR	AD, PDD-NOS
	Smith 2010[359]	All < 6 years with ADOS/ADI/ DSM-IV diagnosis of ASD	53	53	100	50.1	10	–	Months	47	6	Autism
	Taylor 2012[436]	Mothers of ASD children aged mean 3.72 years (SD = 1.82) and 4.18 (SD = 2.65) at diagnosis	75 (mothers)	75	100	3.72	18.2	–	Months	NR	NR	ASD
	Hartley 2009[323]	Children aged 1.5 to 3.9 years based on DSM-IV-TR criteria and ADOS-G classification	499	199	40	–	–	18–48	Months	157	42	AD, PDD-NOS
Sense and Self-Regulation Checklist (SSC)	Silva 2009[226]	3–6 years with DSM-IV diagnosis of ASD	46	46	100	59.2	–	–	Months	37	9	Autism
	Silva 2011[301]	3–6 years old with clinical diagnosis of ASD	47	47	100	4.83	–	3–6	Years	33	14	Autism
Sleep diaries[a]	Escalona 2001[271]	Children were aged 3–6 years based on DSM-III-R	20	20	100	5.2	1.8	3–6	Years	12	8	Autism

AD, autistic disorder; DSM-IV-TR, *Diagnostic and Statistical Manual of Mental Disorders*-Fourth Edition-Text Revision; F, female; M, male; NR, not reported; SD, standard deviation.
a Tools developed ad hoc.

Learning	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
Autism Screening Instrument for Educational Planning (ASIEP)	Arick 2003[388]	Children between the ages of 2 and 6 years (at baseline) who have been said to have a diagnosis of autism; details of criteria used not provided	67	67	100	–	–	2–6	Years	NR	NR	ASD
Extended Basic Academic Skills Assessment System	Arick 2003[388]	Children between the ages of 2 and 6 years (at baseline) who have been said to have a diagnosis of autism; details of criteria used not provided	67	67	100	–	–	2–6	Years	NR	NR	ASD
Wechsler Individualised Achievement Test	Smith 2000[413]	18–42 months with 'clinical' diagnosis of ASD	28	28	100	35.92	–	–	Months	23	5	Autism, PDD-NOS
Student Learning Profile[a]	Arick 2003[388]	Children between the ages of 2 and 6 years (at baseline) who have been said to have a diagnosis of autism; details of criteria used not provided	67	67	100	–	–	2–6	Years	NR	NR	ASD
Classroom Observation Form[b]	Arick 2003[388]	Children between the ages of 2 and 6 years (at baseline) who have been said to have a diagnosis of autism; details of criteria used not provided	67	67	100	–	–	2–6	Years	NR	NR	ASD

F, female; M, male; NR, not reported; SD, standard deviation.
a Tools developed ad hoc.
b Observational coding.

Daily living skills	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
Functional Independence Measure for Children (WeeFIM)	Jasmin 2009[384]	Children aged 3–4 years who had a diagnosis of ASD based on DSM-IV criteria	35	35	100	–	–	3–4	Years	32	3	Autistic, PDD-NOS, Asperger syndrome
Vineland Adaptive Behavior Scales-Classroom version (VABS-Classroom)	Goin-Kochel 2007[427]	Children were aged between 29.6–61.4 months; diagnosis was based on ADOS criteria	29	29	100	45.7	9.6	29.6–61.4	Months	27	2	Autism, PDD-NOS
Vineland Adaptive Behavior Scales (VABS)	Aldred 2004[318]	2 years to 5 years 11 months with ADI diagnosis	28	28	100	–	–	24–71	Months	25	3	AD or 'classical autism'
	Anan 2008[396]	25 to 68 months old children who met the diagnosis of ASD based on DSM-IV criteria	72	72	100	–	–	25–68	Months	61	11	AD, PDD-NOS
	Andersson 2013[409]	Children aged 1.8 to 3.9 years who met DSM-IV criteria	40	37	93	–	–	1.8–3.9	Years	18	19	AD, ASD, atypical autism, Asperger syndrome
	Arick 2003[388]	Children between the ages of 2 and 6 years (at baseline) who have been said to have a diagnosis of autism; details of criteria used not provided	67	67	100	–	–	2–6	Years	NR	NR	ASD
	Baghdadli 2012[339]	Age < 7 years, ICD-10 diagnosis of autism	280	280	100	4.9	1.3	–	Months	230	50	Childhood autism, atypical autism
	Bearss 2013[278]	Children were aged between 3 years and 6 years 11 months, and assessed to have autism based on ADOS and clinical observation	16	16	100	–	–	3–6	Years	16	0	AD, PDD-NOS
	Ben Itzchak 2011[320]	Children aged 15–35 months were included in the study	78	78	100	–	–	15–35	Months	71	7	Autism
	Bennett 2008[296]	Children aged between 4 and 6 years	64	64	100	–	–	4–6	Years	57	7	Asperger syndrome, high-functioning autism

Daily living skills	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
	Carlsson 2013[390]	Children aged from 4.5 to 6.5 years who were assessed to have autism based on DSM-IV criteria	198	119	60	–	–	4.5–6.5	Years	NR	NR	Autistic-like condition, Asperger syndrome, autistic traits
	Cassidy 2008[348]	Parents of children aged < 5 years with ICD-10 diagnosis of ASD	104	104	100	–	–	2–4	Years	95	9	ASD
	Dawson 2010[321]	18–30 months, diagnosed by ADOS, ADI and DSM-IV	48	48	100	–	–	18–33	Months	37	11	AD, PDD-NOS
	Eapen 2013[357]	Mean age of 49.6 months	26	26	100	49.6	6.08	36–58	Months	21	5	AD
	Eikeseth 2009[410]	24–42 months with ICD-10 diagnosis of ASD	23	23	100	34.9	5.7	28–42	Months	17	6	Autism
	Eldevik 2012[414]	Children aged 2 to 6 who had autism diagnosis based on ICD-10 criteria and ADI-R	43	43	100	4.26	1.48	1–6	Years	33	10	Autism, PDD-NOS, Asperger
	Eriksson 2013[415]	Children aged 20–54 months. Criteria not stated	208	208	100	–	–	20–54	Months	176	32	ASD
	Gabriels 2007[416]	Children had a mean age of 31 months and had a clinical diagnosis of autistic disorder or PDD-NOS based on DSM-IV criteria	14	14	100	31	–	–	Months	10	4	AD, PDD-NOS
	Green 2010[253]	24–60 months, ADOS or ADI diagnosed	152	152	100	45	–	24–60	Months	138	14	Core autism
	Grindle 2012[417]	3- to 7-year-old children with autism	29	29	100	–	–	43–72	Months	25	4	Autism
	Hedvall 2013[418]	3.6- to 6.6-year-old children with ASD	190	168	88	55	0.8	42–76	Months	147	21	AD, PDD-NOS, Asperger syndrome
	Herring 2006[411]	Children were aged between 20 and 51 months who met the DSM-IV criteria for diagnosis	123	84	68	37.75	7.07	–	Months	75	9	AD, PDD-NOS

Daily living skills	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
	Honey 2008[307]	24–48 months diagnosed by ICD-10 criteria	104	79	76	37.05	6.08	24–48	Months	65	14	ASD
	Hudry 2010[233]	24- to 59-month-old children with ADOS-G diagnosis	152	152	100	44.83	7.98	24–59	Months	138	14	Core autism
	Jasmin 2009[384]	Children aged 3–4 years who had a diagnosis of ASD based on DSM-IV criteria	35	35	100	–	–	3–4	Years	32	3	Autistic, PDD-NOS, Asperger syndrome
	Jonsdottir 2007[341]	Mean age was 41.43 months; diagnosis was based on ICD-10 criteria	41	41	100	41.43	9.06	22–59	Months	34	7	Childhood autism
	Klintwall 2012[419]	2 years and 3 months to 4 years and 11 months, with clinical diagnosis by paediatrician	21	21	100	3.6	–	2.25–4.9	Years	16	5	Autism
	Landa 2012[224]	22- to 33-month-old children with ASD or autism	48	48	100	27	2.8	22–33	Months	39	9	ASD
	Lerna 2012[325]	18–60 months old with diagnosis of autism and little or no functional language	18	18	100	–	–	18–60	Months	17	1	Autism
	Lloyd 2013[400]	12- to 36-month-old children with ASD	162	162	100	–	–	12–37	Months	140	22	ASD
	Luyster 2008[129]	Participants were aged 18–33 months and met ADI-R criteria for ASD diagnosis	164	164	100	–	–	18–33	Months	129	35	ASD
	Magiati 2007[308]	Children aged between 22 and 54 months who met ADI-R criteria for autism/ASD diagnosis	44	44	100	–	–	22–54	Months	39	5	Autism, ASD
	Magiati 2011[309]	Mean age of 3.4 years at start of the study	44	44	100	38.9	7.1	27–55	Months	39	5	Autism, ASD
	Mayo 2013[310]	45–72 months with DSM-IV-TR criteria	119	119	100	52.22	6.09	45–72	Months	99	20	AD, PDD-NOS

Daily living skills	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
	McConkey 2010[349]	Children with ASD diagnosis (criteria not given, it was only stated as 'confirmed diagnosis of ASD from a specialist clinic') who had a mean age of 2.8 years at start of the study	62 (families)	61	98	–	–	< 4	Years	55	6	Autism
	Munson 2006[420]	38–54 months with DSM-IV diagnosis of ASD	45	45	100	47.4	4.2	38–54	Months	38	7	AD, PDD-NOS
	Munson 2008[312]	24–66 months with ADI or ADOS diagnosis of ASD	456	456	100	43.4	8.7	24–66	Months	370	86	Autism, ASD
	O'Donnell 2012[386]	3–4 years old with DSM-IV diagnosis of ASD	42	42	100	45.5	–	36–59	Months	NR	NR	Autism, PDD-NOS
	Osborne 2008[350]	2.6–4 years old with GARS diagnosis of ASD	65	65	100	–	–	2.6–4.0	Years	59	6	ASD
	Osborne 2009[351]	2.6–4 years old with GARS diagnosis of ASD	65	65	100	3.4	0.75	2.6–4.0	Years	59	6	ASD
	Peters-Scheffer 2010[421]	3- to 6-year-old children with DSM-IV diagnosis of AD or PDD-NOS	34	34	100	53.5	5.52	42–62	Months	NR	NR	AD, PDD-NOS
	Poon 2012[401]	9–12 months (upon entering study) with ADOS, ADI or CARS diagnosis of ASD	29	29	100	4.46	1.49	–	Months	24	5	AD, PDD-NOS, Asperger syndrome
	Pry 2005[314]	21 months to 7 years with ICD-10 diagnosis of ASD	222	222	100	5	1.75	1.75–7	Years	180	42	Infantile autism
	Ray-Subramanian 2011[327]	23–39 months with DSM-IV or ICD-10 diagnosis of ASD	125	125	100	31	4.1	23–39	Months	108	17	Autism, AD, PDD-NOS
	Reed 2007[352]	2 years 6 months to 4 years old diagnosed with ASD	27	27	100	–	–	2.5–4.0	Years	27	0	ASD
	Reed 2007[353]	2 years 6 months to 4 years old with 'paediatrician' diagnosis of ASD	53	53	100	–	–	2.5–4.0	Years	Unclear	Unclear	ASD
	Reed 2012[354]	2.5–4 years with GARS diagnosis of ASD	66	66	100	40.2	5.6	–	Months	59	7	AD, PDD-NOS

Daily living skills	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
	Remington 2007[358]	30–42 months of age with ADI diagnosis of ASD	44	44	100	37	4.2	30–42	Months	NR	NR	Autism or suspected autism
	Restall 1994[422]	3–6 years with DSM-III diagnosis of ASD	18	9	50	64.76	6.4	–	Months	8	1	Autism
	Rickards 2009[423]	3–5 years, 35/59 diagnosed ASD by DSM-IV criteria	54	54	100	69.65	–	–	Months	43	11	ASD
	Roberts 2011[405]	2.2–5 years with DSM-IV diagnosis of ASD	95	95	100	–	–	26.3–60.3	Months	86	9	AD, ASD
	Rogers 2012[317]	14–24 months with ASD	98	98	100	21	–	–	Months	76	22	ASD
	Ruble 2008[424]	40–71 months with DSM-IV diagnosis of ASD	35	35	100	55.9	–	40.9–70.9	Months	30	5	Autism
	Salt 2002[372]	Preschool children in Scotland, (mean 42.36 months) with ICD-10 diagnosis of ASD	17	17	100	40.02	–	–	Months	14	3	Childhood autism
	Schertz 2013[402]	Mean age 24.6 and 27.5 months with ADOS diagnosis	23	23	100	26.05	–	–	Months	NR	NR	ASD
	Silva 2007[299]	3–6 years old with DSM-IV diagnosis of ASD	15	15	100	4.83	–	3–6	Years	13	2	AD
	Silva 2008[300]	3–6 years old with DSM-IV diagnosis of ASD	26	26	100	56.3	12.5	–	Months	21	5	Autism
	Smith 2000[413]	18–42 months with 'clinical' diagnosis of ASD	28	28	100	35.92	–	–	Months	23	5	Autism, PDD-NOS
	Smith 2010[359]	All < 6 years with ADOS/ADI/DSM-IV diagnosis of ASD	53	53	100	50.1	10	–	Months	47	6	Autism
	Stahmer 2004[355]	0–3 years with DSM-IV diagnosis	20	20	100	29.6	–	22–33	Months	16	4	AD, PDD-NOS
	Stone 1999[346]	23–35 months with DSM-III or DSM-IV diagnosis of ASD	60	30	50	31.3	3.3	23–35	Months	25	5	Autism
	Strauss 2012[329]	26–81 months with DSM-IV diagnosis of ASD	44	44	100	–	–	26–81	Months	41	3	Autism, PDD-NOS

Daily living skills	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
	Szatmari 2000[302]	4- to 6-year-old children (upon entering study) diagnosed by ADI	134	68	51	66.8	–	–	Months	59	7	Autism, Asperger syndrome
	Tonge 2012[425]	Children were aged 2.5–5 years and diagnosis was made using a combination of medical reviews, ADI-R and CARS	107	107	100	–	–	2.5–5.0	Years	90	17	AD
	Toth 2006[284]	34–52 months with ADI-diagnosis of ASD	60	60	100	43.6	4.3	34–52	Months	51	9	AD, PDD-NOS
	VanMeter 1997[426]	Mean ages ranged from 2.9 (SD = 0.77) to 5.7 (SD = 1.31) years meeting DSM-III criteria for ASD	143	57	40	–	–	5.2–6.0	Years	54	3	AD
	Ventola 2007[332]	16–32 months old with M-CHAT diagnosis of ASD	195	195	100	–	–	16–32	Months	152	43	ASD
	Werner 2005[316]	12–57 months with DSM-IV diagnosis of ASD	145	72	50	43.5	4.3	–	Months	60	12	AD, PDD-NOS
	Zachor 2010[335]	15- to 35-month-old children who met DSM-IV criteria	71	71	100	25.55	4.25	15–35	Months	71	7	Autism
Video coding of feeding behaviour[a]	Brisson 2012[449]	3- to 6-month-old children later diagnosed with an ASD	27	13	48	–	–	3–6	Months	13+	NR	AD, ASD

AD, autistic disorder; DSM-IV-TR, *Diagnostic and Statistical Manual of Mental Disorders*-Fourth Edition-Text Revision; F, female; M, male; NR, not reported; SD, standard deviation.
a Observational coding.

Global measure of function	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
Ages and Stages Questionnaire (ASQ)	Feldman 2012[104]	Children who aged between 1 and 24 months who were 'at risk' for autism (they had a sibling with a diagnosis of ASD, Asperger syndrome or PDD-NOS)	108 (parents)	108	100	8	5	–	Months	74	34	AD, PDD-NOS, Asperger syndrome and high-functioning autism
Assessment of Basic Language and Learning Skills (ABLLS)	Goin-Kochel 2007[427]	Children were aged between 29.6–61.4 months; diagnosis was based on ADOS criteria	29	29	100	45.7	9.6	29.6–61.4	Months	27	2	Autism, PDD-NOS
	Grindle 2012[417]	3- to 7-year-old children with autism	29	29	100	–	–	43–72	Months	25	4	Autism
	Gupta 2009[303]	Children had a mean age of 4.8 years at start of the study and were diagnosed of autism based on DSM-IV-TR criteria	40	20	50	4.16	0.86	–	Years	12	8	Autism
Assessment, Evaluation and Programming System (AEPS)	Schwartz 2004[450]	3–6 years old with CARS diagnosis of ASD	48	48	100	–	–	3–6	Years	37	11	Autism, PDD-NOS
Behavior Assessment System for Children-Second Edition (BASC-2)	Hill-Chapman 2013[434]	Parents of children with ASD	56 (parents)	56	100	3.98	1.31	–	Years	N/A	N/A	AD, PDD-NOS, Asperger syndrome
Brigance Diagnostic Inventory of Early Development	Travers 2011[438]	3–6 years meeting a 'state educational definition of Autism'	17	17	100	–	–	3–6	Years	NR	NR	Autism
Developmental Profile	Malhi 2011[342]	Children were $\leq$ 3 years at start of the study and had an ASD diagnosis based on DSM-IV criteria	77	77	100	–	–	0–3	Years	64	13	AD, PDD-NOS
Early Development Interview	Werner 2005[316]	12–57 months with DSM-IV diagnosis of ASD	145	72	50	43.5	4.3	–	Months	60	12	AD, PDD-NOS
Early Intervention Developmental Profile (EIDP)	Jocelyn 1998[298]	24- to 72-month-old children who met DSM-III-R criteria	35	35	100	43.2	9.1	–	Months	27	8	Autism, PDD-NOS

Global measure of function	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
Early Learning Accomplishment Profile (E-LAP)	Virues-Ortega 2013[451]	Mean age 51.91 (SD = 27.31) with DSM-IV diagnosis	24	24	100	51.91	27.3	–	Months	21	3	ASD
Functional Emotional Developmental Questionnaire	Pajareya 2012[343]	2–6 years old with ASD	34	34	100	4.23	1.16	2–6	Years	30	4	Autism, PDD-NOS
	Pajareya 2011[344]	24–72 months old with DSM-IV diagnosis for ASD	32	32	100	54.05	–	24–72	Months	28	4	Autism, PDD-NOS
Learning Accomplishment Profile-Diagnostic, Third Edition (LAP-D)	Virues-Ortega 2013[451]	Mean age 51.91 (SD = 27.31) with DSM-IV diagnosis	24	24	100	51.91	27.3	–	Months	21	3	ASD
Paediatric Daily Occupation Scale	Hsieh 2013[452]	Parents of children with ASD	40	40	100	5	0.9	2.5–6.0	Years	35	5	Autism, PDD-NOS, Asperger
Preschool Developmental Profile (PSDP)	Jocelyn 1998[298]	24- to 72-month-old children who met DSM-III-R criteria	35	35	100	43.2	9.1	–	Months	27	8	Autism, PDD-NOS
Psychoeducational Profile-Revised (PEP-R)	Delmolino 2006[432]	Mean age was 44 months (range = 37 to 60 months). Diagnosis was made prior to inclusion in the study and confirmed using ADOS and ADI-R	27	27	100	–	–	3–6	Years	23	4	Autism, PDD-NOS
	Herring 2006[411]	Children were aged between 20 and 51 months who met the DSM-IV criteria for diagnosis	123	84	68	37.75	7.07	–	Months	75	9	AD, PDD-NOS
	McConkey 2010[349]	Children with ASD diagnosis (criteria not given, it was only stated as 'confirmed diagnosis of ASD from a specialist clinic') who had a mean age of 2.8 years at start of the study	62 (families)	61	98	–	–	< 4	Years	55	6	Autism
	Osborne 2008[350]	2.6–4.0 years old with GARS diagnosis of ASD	65	65	100	–	–	2.6–4.0	Years	59	6	ASD
	Ozonoff 1998[453]	31–69 months diagnosed by CARS	22	11	50	53.3	12.3	31–69	Months	9	2	Autism

Global measure of function	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
	Reed 2007[352]	2 years 6 months to 4 years old diagnosed with ASD	27	27	100	–	–	2.5–4.0	Years	27	0	ASD
	Reed 2007[353]	2 years 6 months to 4 years old with 'paediatrician' diagnosis of ASD	53	53	100	–	–	2.5–4.0	Years	Unclear	Unclear	ASD
	Reed 2012[354]	2.5–4 years with GARS diagnosis of ASD	66	66	100	40.2	5.6	–	Months	59	7	AD, PDD-NOS
	Tonge 2012[425]	Children were aged 2.5–5 years and diagnosis was made using a combination of medical reviews, ADI-R and CARS	107	107	100	–	–	2.5–5.0	Years	90	17	AD
Scales of Independent Behavior-Revised (SIB-R)	Keen 2010[363]	Children aged 2–4 years who met the DSM-IV criteria for ASD diagnosis	39	39	100	–	–	2–4	Years	34	5	ASD
Vineland Adaptive Behavior Scales-Classroom version (VABS-Classroom)	Goin-Kochel 2007[427]	Children were aged between 29.6–61.4 months; diagnosis was based on ADOS criteria	29	29	100	45.7	9.6	29.6–61.4	Months	27	2	Autism, PDD-NOS
Vineland Adaptive Behavior Scales (VABS)	Aldred 2004[318]	2 years to 5 years 11 months with ADI diagnosis	28	28	100	–	–	24–71	Months	25	3	AD or 'classical autism'
	Anan 2008[396]	25 to 68 months old children who met the diagnosis of ASD based on DSM-IV criteria	72	72	100	–	–	25–68	Months	61	11	AD, PDD-NOS
	Andersson 2013[409]	Children aged 1.8 to 3.9 years who met DSM-IV criteria	40	37	93	–	–	1.8–3.9	Years	18	19	AD, ASD, atypical autism, Asperger syndrome
	Arick 2003[388]	Children between the ages of 2 and 6 years (at baseline) who have been said to have a diagnosis of autism; details of criteria used not provided	67	67	100	–	–	2–6	Years	NR	NR	ASD

Global measure of function	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
	Baghdadli 2012[339]	Age < 7 years, ICD-10 diagnosis of autism	280	280	100	4.9	1.3	–	Months	230	50	Childhood autism, atypical autism
	Bearss 2013[278]	Children were aged between 3 years and 6 years 11 months, and assessed to have autism based on ADOS and clinical observation	16	16	100	–	–	3–6	Years	16	0	AD, PDD-NOS
	Ben Itzchak 2011[320]	Children aged 15–35 months were included in the study	78	78	100	–	–	15–35	Months	71	7	Autism
	Bennett 2008[296]	Children aged between 4 and 6 years	64	64	100	–	–	4–6	Years	57	7	Asperger syndrome, high-functioning autism
	Carlsson 2013[390]	Children aged from 4.5 to 6.5 years who were assessed to have autism based on DSM-IV criteria	198	119	60	–	–	4.5–6.5	Years	NR	NR	Autistic-like condition, Asperger syndrome, autistic traits
	Cassidy 2008[348]	Parents of children aged < 5 years with ICD-10 diagnosis of ASD	104	104	100	–	–	2–4	Years	95	9	ASD
	Dawson 2010[321]	18–30 months, diagnosed by ADOS, ADI and DSM-IV	48	48	100	–	–	18–33	Months	37	11	AD, PDD-NOS
	Eapen 2013[357]	Mean age of 49.6 months	26	26	100	49.6	6.08	36–58	Months	21	5	AD
	Eikeseth 2009[410]	24–42 months with ICD-10 diagnosis of ASD	23	23	100	34.9	5.7	28–42	Months	17	6	Autism
	Eldevik 2012[414]	Children aged 2 to 6 who had autism diagnosis based on ICD-10 criteria and ADI-R	43	43	100	4.26	1.48	1–6	Years	33	10	Autism, PDD-NOS, Asperger
	Eriksson 2013[415]	Children aged 20–54 months. Criteria not stated	208	208	100	–	–	20–54	Months	176	32	ASD
	Gabriels 2007[416]	Children had a mean age of 31 months and had a clinical diagnosis of autistic disorder or PDD-NOS based on DSM-IV criteria	14	14	100	31	–	–	Months	10	4	AD, PDD-NOS

Global measure of function	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
	Green 2010[253]	24–60 months, ADOS or ADI diagnosed	152	152	100	45	–	24–60	Months	138	14	Core autism
	Grindle 2012[417]	3- to 7-year-old children with autism	29	29	100	–	–	43–72	Months	25	4	Autism
	Hedvall 2013[418]	3.6- to 6.6-year-old children with ASD	190	168	88	55	0.8	42–76	Months	147	21	AD, PDD-NOS, Asperger syndrome
	Herring 2006[411]	Children were aged between 20 and 51 months who met the DSM-IV criteria for diagnosis	123	84	68	37.75	7.07	–	Months	75	9	AD, PDD-NOS
	Honey 2008[307]	24–48 months diagnosed by ICD-10 criteria	104	79	76	37.05	6.08	24–48	Months	65	14	ASD
	Hudry 2010[233]	24- to 59-month-old children with ADOS-G diagnosis	152	152	100	44.83	7.98	24–59	Months	138	14	Core autism
	Jasmin 2009[384]	Children aged 3–4 years who had a diagnosis of ASD based on DSM-IV criteria	35	35	100	–	–	3–4	Years	32	3	Autistic, PDD-NOS, Asperger syndrome
	Jonsdottir 2007[341]	Mean age was 41.43 months; diagnosis was based on ICD-10 criteria	41	41	100	41.43	9.06	22–59	Months	34	7	Childhood autism
	Klintwall 2012[419]	2 years and 3 months to 4 years and 11 months, with clinical diagnosis by paediatrician	21	21	100	3.6	–	2.25–4.9	Years	16	5	Autism
	Landa 2012[224]	22- to 33-month-old children with ASD or autism	48	48	100	27	2.8	22–33	Months	39	9	ASD
	Lerna 2012[325]	18–60 months old with diagnosis of autism and little or no functional language	18	18	100	–	–	18–60	Months	17	1	Autism
	Lloyd 2013[400]	12- to 36-month-old children with ASD	162	162	100	–	–	12–37	Months	140	22	ASD

Global measure of function	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
	Luyster 2008[129]	Participants were aged 18–33 months and met ADI-R criteria for ASD diagnosis	164	164	100	–	–	18–33	Months	129	35	ASD
	Magiati 2007[308]	Children aged between 22 and 54 months who met ADI-R criteria for autism/ASD diagnosis	44	44	100	–	–	22–54	Months	39	5	Autism, ASD
	Magiati 2011[309]	Mean age of 3.4 years at start of the study	44	44	100	38.9	7.1	27–55	Months	39	5	Autism, ASD
	Mayo 2013[310]	45–72 months with DSM-IV-TR criteria	119	119	100	52.22	6.09	45–72	Months	99	20	AD, PDD-NOS
	McConkey 2010[349]	Children with ASD diagnosis (criteria not given, it was only stated as 'confirmed diagnosis of ASD from a specialist clinic') who had a mean age of 2.8 years at start of the study	62 (families)	61	98	–	–	< 4	Years	55	6	Autism
	Munson 2006[420]	38–54 months with DSM-IV diagnosis of ASD	45	45	100	47.4	4.2	38–54	Months	38	7	AD, PDD-NOS
	Munson 2008[312]	24–66 months with ADI or ADOS diagnosis of ASD	456	456	100	43.4	8.7	24–66	Months	370	86	Autism, ASD
	O'Donnell 2012[386]	3–4 years old with DSM-IV diagnosis of ASD	42	42	100	45.5	–	36–59	Months	NR	NR	Autism, PDD-NOS
	Osborne 2008[350]	2.6–4 years old with GARS diagnosis of ASD	65	65	100	–	–	2.6–4.0	Years	59	6	ASD
	Osborne 2009[351]	2.6–4 years old with GARS diagnosis of ASD	65	65	100	3.4	0.75	2.6–4.0	Years	59	6	ASD
	Peters-Scheffer 2010[421]	3- to 6-year-old children with DSM-IV diagnosis of AD or PDD-NOS	34	34	100	53.5	5.52	42–62	Months	NR	NR	AD, PDD-NOS
	Poon 2012[401]	9–12 months (upon entering study) with ADOS, ADI or CARS diagnosis of ASD	29	29	100	4.46	1.49	–	Months	24	5	AD, PDD-NOS, Asperger syndrome

Global measure of function	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
	Pry 2005[314]	21 months to 7 years with ICD-10 diagnosis of ASD	222	222	100	5	1.75	1.75–7	Years	180	42	Infantile autism
	Ray-Subramanian 2011[327]	23–39 months with DSM-IV or ICD-10 diagnosis of ASD	125	125	100	31	4.1	23–39	Months	108	17	Autism, AD, PDD-NOS
	Reed 2007[352]	2 years 6 months to 4 years old diagnosed with ASD	27	27	100	–	–	2.5–4.0	Years	27	0	ASD
	Reed 2007[353]	2 years 6 months to 4 years old with 'paediatrician' diagnosis of ASD	53	53	100	–	–	2.5–4.0	Years	Unclear	Unclear	ASD
	Reed 2012[354]	2.5–4 years with GARS diagnosis of ASD	66	66	100	40.2	5.6	–	Months	59	7	AD, PDD-NOS
	Remington 2007[358]	30–42 months of age with ADI diagnosis of ASD	44	44	100	37	4.2	30–42	Months	NR	NR	Autism or suspected autism
	Restall 1994[422]	3–6 years with DSM-III diagnosis of ASD	18	9	50	64.76	6.4	–	Months	8	1	Autism
	Rickards 2009[423]	3–5 years, 35/59 diagnosed ASD by DSM-IV criteria	54	54	100	69.65	–	–	Months	43	11	ASD
	Roberts 2011[405]	2.2–5 years with DSM-IV diagnosis of ASD	95	95	100	–	–	26.3–60.3	Months	86	9	AD, ASD
	Rogers 2012[317]	14–24 months with ASD	98	98	100	21	–	–	Months	76	22	ASD
	Ruble 2008[424]	40–71 months with DSM-IV diagnosis of ASD	35	35	100	55.9	–	40.9–70.9	Months	30	5	Autism
	Salt 2002[372]	Preschool children in Scotland, (mean 42.36 months) with ICD-10 diagnosis of ASD	17	17	100	40.02	–	–	Months	14	3	Childhood autism
	Schertz 2013[402]	Mean age 24.6 and 27.5 months with ADOS diagnosis	23	23	100	26.05	–	–	Months	NR	NR	ASD
	Silva 2007[299]	3–6 years old with DSM-IV diagnosis of ASD	15	15	100	4.83	–	3–6	Years	13	2	AD

Global measure of function	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
	Silva 2008[300]	3–6 years old with DSM-IV diagnosis of ASD	26	26	100	56.3	12.5	–	Months	21	5	Autism
	Smith 2000[413]	18–42 months with 'clinical' diagnosis of ASD	28	28	100	35.92	–	–	Months	23	5	Autism, PDD-NOS
	Smith 2010[359]	All < 6 years with ADOS/ADI/DSM-IV diagnosis of ASD	53	53	100	50.1	10	–	Months	47	6	Autism
	Stahmer 2004[355]	0–3 years with DSM-IV diagnosis	20	20	100	29.6	–	22–33	Months	16	4	AD, PDD-NOS
	Stone 1999[346]	23–35 months with DSM-III or DSM-IV diagnosis of ASD	60	30	50	31.3	3.3	23–35	Months	25	5	Autism
	Strauss 2012[329]	26–81 months with DSM-IV diagnosis of ASD	44	44	100	–	–	26–81	Months	41	3	Autism, PDD-NOS
	Szatmari 2000[302]	4- to 6-year-old children (upon entering study) diagnosed by ADI	134	68	51	66.8	–	–	Months	59	7	Autism, Asperger syndrome
	Tonge 2012[425]	Children were aged 2.5–5 years and diagnosis was made using a combination of medical reviews, ADI-R and CARS	107	107	100	–	–	2.5–5.0	Years	90	17	AD
	Toth 2006[284]	34–52 months with ADI-diagnosis of ASD	60	60	100	43.6	4.3	34–52	Months	51	9	AD, PDD-NOS
	VanMeter 1997[426]	Mean ages ranged from 2.9 (SD = 0.77) to 5.7 (SD = 1.31) years meeting DSM-III criteria for ASD	143	57	40	–	–	5.2–6.0	Years	54	3	AD

Global measure of function	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
	Ventola 2007[332]	16–32 months old with M-CHAT diagnosis of ASD	195	195	100	–	–	16–32	Months	152	43	ASD
	Werner 2005[316]	12–57 months with DSM-IV diagnosis of ASD	145	72	50	43.5	4.3	–	Months	60	12	AD, PDD-NOS
	Zachor 2010[335]	15- to 35-month-old children who met DSM-IV criteria	71	71	100	25.55	4.25	15–35	Months	71	7	Autism
Social Adaptive Development Quotient Scale (ADQ)[a]	Zhang 2012[303]	76 children with ASD (mean age 4.09, SD 1.66)	96	96	100	4.37	1.6	–	Years	68	8	Autistic

AD, autistic disorder; DSM-IV-TR, *Diagnostic and Statistical Manual of Mental Disorders*-Fourth Edition-Text Revision; F, female; M, male; N/A, not available; NR, not reported; SD, standard deviation.
a Non-UK.

Global measure of outcome	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
Autism Treatment Evaluation Checklist (ATEC)	Goin-Kochel 2007[427]	Children were aged between 29.6–61.4 months; diagnosis was based on ADOS criteria	29	29	100	45.7	9.6	29.6–61.4	Months	27	2	Autism, PDD-NOS
Behavioral Summarized Evaluation-Revised (BSE-R)	Receveur 2005[337]	Observed from 10 months old to 4 years old – met DSM-IV criteria for ASD	18	18	100	58	3.2	10–59	Months	13	5	AD
Behavioral Summarized Evaluation (BSE)	Maestro 2005[338]	Videos of first year of life observed, all met DSM-IV criteria for ASD	40	40	100	–	–	0–1	Years	32	8	AD, PDD-NOS
Clinical Global Impression Improvement Scale	Bearss 2013[278]	Children were aged between 3 years and 6 years 11 months, and assessed to have autism based on ADOS and clinical observation	16	16	100	–	–	3–6	Years	16	0	AD, PDD-NOS
	Oosterling 2010[326]	12–42 months old with 'clinical' diagnosis of ASD	80	80	100	34.8	–	–	Months	62	18	Autism, PDD-NOS
Infant Behavioral Summarized Evaluation (IBSE)	Adrien 1992[90]	0–2 years, DSM-III-R criteria	24	12	50	–	–	0–2	Years	10	2	Autism
	Receveur 2005[337]	Observed from 10 months old to 4 years old – met DSM-IV criteria for ASD	18	18	100	58	3.2	10–59	Months	13	5	AD
Pervasive Developmental Disorders Behavior Inventory (PDDBI)	Silva 2009[226]	3–6 years with DSM-IV diagnosis of ASD	46	46	100	59.2	–	–	Months	37	9	Autism
	Silva 2011[301]	3–6 years old with clinical diagnosis of ASD	47	47	100	4.83	–	3–6	Years	33	14	Autism

AD, autistic disorder; F, female; M, male; SD, standard deviation.

Subjective well-being	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
Kiddie–Infant Descriptive Instrument for Emotional States (KIDIES)[a]	Trad 1993[454]	24–55 months with DSM-III diagnosis of ASD	47	26	55	39	–	24–55	Months	NR	NR	AD, PDD-NOS

AD, autistic disorder; F, female; M, male; NR, not reported; SD, standard deviation.
a Pre-1995.

Social inclusion	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
School Liking and Avoidance Questionnaire	Jahromi 2013[431]	20 TD and 20 children with high-functioning autism	40	20	50	58.95	11.5	–	Months	36	4	High-functioning autism
Teacher Rating Scale of School Adjustment	Jahromi 2013[431]	20 TD and 20 children with high-functioning autism	40	20	50	58.95	11.5	–	Months	36	4	High-functioning autism

F, female; M, male; SD, standard deviation; TD, typically developing.

Interaction style	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
Functional Emotional Assessment Scale	Pajareya 2012[343]	2–6 years old with ASD	34	34	100	4.23	1.16	2–6	Years	30	4	Autism, PDD-NOS
	Pajareya 2011[344]	24–72 months old with DSM-IV diagnosis for ASD	32	32	100	54.05	–	24–72	Months	28	4	Autism, PDD-NOS
NICHD Early Child Care Network scales	Baker 2010[397]	33 'at-risk' children, entered study between ages of 2–18 months, assessed at 18, 24, 30 and 36 months.	33	12	36	18	–	–	Months	NR	NR	ASD
Coded observation of social behaviour[a]	Meirsschaut 2011[442]	21–56 months meeting ADOS criteria for ASD	42	21	50	36.94	–	21–56	Months	18	3	Autism, ASD
Coding of videos[a]	Flippin 2011[406]	Children aged 40–69 months with autism diagnosis based on ADOS	16	16	100	53.3	9.6	40–69	Months	12	4	ASD
Parental skills – video ratings[a]	Oosterling 2010[326]	12–42 months old with 'clinical' diagnosis of ASD	80	80	100	34.8	–	–	Months	62	18	Autism, PDD-NOS
Parent–child free play[a]	Freeman 2013[443]	18- to 55-month-old children, 50 met DSM-IV criteria	32 (parent–child dyads)	16	50	49.5	11.8	–	Months	12	4	Autism
Parent–child interaction[a]	Green 2010[253]	24–60 months, ADOS or ADI diagnosed	152	152	100	45	–	24–60	Months	138	14	Core autism
Parent–Child Interaction measure[a]	Aldred 2012[319]	Children aged 2–5 years assessed using ADOS and ADI-R	28	28	100	–	–	2–5	Years	25	3	Autism
Preschool teacher–child play[a]	Kaale 2012[294]	Children aged 29–60 months who had a diagnosis of autistic disorder based on ICD-10 criteria	61	61	100	–	–	24–60	Months	48	13	Autism
Social Interaction Rating Scale[a]	Ruble 2008[424]	40–71 months with DSM-IV diagnosis of ASD	35	35	100	55.9	–	40.9–70.9	Months	30	5	Autism

F, female; M, male; NR, not reported; SD, standard deviation.
a Observational coding.

Parent stress	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
Autism Parenting Stress Index (PSI) (APSI)	Silva 2011[301]	3–6 years old with clinical diagnosis of ASD	47	47	100	4.83	–	3–6	Years	33	14	Autism
Beck Anxiety Inventory	Davis 2008[455]	Children had a mean age of 26.9 months	54 (parents)	54	100	26.9	4.2	–	Months	40	14	Autism, PDD-NOS
Center for Epidemiologic Studies Depression Inventory	Davis 2008[455]	Children had a mean age of 26.9 months	54 (parents)	54	100	26.9	4.2	–	Months	40	14	Autism, PDD-NOS
Center for Epidemiologic Studies Depression Inventory	Taylor 2012[436]	Mothers of ASD children aged mean 3.72 years (SD = 1.82) and 4.18 (SD = 2.65) at diagnosis	75 (mothers)	75	100	3.72	18.2	–	Months	NR	NR	ASD
General Health Questionnaire (GHQ)	Herring 2006[411]	Children were aged between 20 and 51 months who met the DSM-IV criteria for diagnosis	123	84	68	37.75	7.07	–	Months	75	9	AD, PDD-NOS
	McConkey 2010[349]	Children with ASD diagnosis (criteria not given, it was only stated as 'confirmed diagnosis of ASD from a specialist clinic') who had a mean age of 2.8 years at start of the study	62 (families)	61	98	–	–	< 4	Years	55	6	Autism
	Tonge 2005[456]	Parents of children 2.5–5 years old with DSM-IV diagnosis of ASD	105 (parents)	103	100	–	–	23–70	Months	87	16	AD
Hospital Anxiety and Depression Scale (HADS)	Remington 2007[358]	30–42 months of age with ADI diagnosis of ASD	44	44	100	37	4.2	30–42	Months	NR	NR	Autism or suspected autism
Parenting Stress Index-Short Form (PSI-SF)	Strauss 2012[329]	26–81 months with DSM-IV diagnosis of ASD	44	44	100	–	–	26–81	Months	41	3	Autism, PDD-NOS

Parent stress	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
Parenting Sense of Competence (PSOC)	Keen 2007[364]	Diagnosis of autism was based on DSM-IV criteria	16	16	100	–	–	2–4	Years	14	2	Autism
	Keen 2010[363]	Children aged 2–4 years who met the DSM-IV criteria for ASD diagnosis	39	39	100	–	–	2–4	Years	34	5	ASD
Parenting Stress Index (PSI)	Aldred 2004[318]	2 years to 5 years 11 months with ADI diagnosis	28	28	100	–	–	24–71	Months	25	3	AD or 'classical autism'
	Baker-Ericzen 2005[457]	Parents of toddlers (mean age 28.35 months) with ASD	60 (parents)	37 (parents)	62	28.35	5.2	–	Months	29	8	ASD
	Keen 2010[363]	Children aged 2–4 years who met the DSM-IV criteria for ASD diagnosis	39	39	100	–	–	2–4	Years	34	5	ASD
	Roberts 2011[405]	2.2–5 years with DSM-IV diagnosis of ASD	95	95	100	–	–	26.3–60.3	Months	86	9	AD, ASD
	Salt 2002[372]	Preschool children in Scotland, (mean 42.36 months) with ICD-10 diagnosis of ASD	17	17	100	40.02	–	–	Months	14	3	Childhood autism
Parenting Stress Index-Short Form (PSI-SF)	Bendixen 2011[458]	Children had a mean age of 4.41 years (SD = 1.36, range = 3–8 years)	19	19	100	4.41	1.36	3–8	Years	18	1	AD
	Davis 2008[455]	Children had a mean age of 26.9 months	54 (parents)	54	100	26.9	4.2	–	Months	40	14	Autism, PDD-NOS
	Hill-Chapman 2013[434]	Parents of children with ASD	56	56	100	3.98	1.31	–	Years	N/A	N/A	AD, PDD-NOS, Asperger syndrome
	Minjarez 2013[459]	2–6 years, with DSM-IV-TR criteria	17	17	100	3.11	1.1	2.5–6.7	Years	17	0	AD, PDD-NOS
	Wang 2013[460]	Mothers of children [mean (SD) = 5.15 years (1.72)] with DSM-IV diagnosis	150	150	100	5.15	1.72	–	Years	124	26	Autism, PDD-NOS, Asperger
	Wong 2010[333]	17–36 months children diagnosed by DSM-IV, ADI and ADOS	17	17	100	–	–	17–36	Months	16	1	–

Parent stress	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
Positive and Negative Affect Scale (PANAS)	Hsieh 2013[452]	Parents of children with ASD	40	40	100	5	0.9	2.5–6.0	Years	35	5	Autism, PDD-NOS, Asperger
Questionnaire on Resources and Stress-Friedrich Short Form (QRS-F)	Cassidy 2008[348]	Parents of children aged < 5 years with ICD-10 diagnosis of ASD	104	104	100	–	–	2–4	Years	95	9	ASD
	McConkey 2010[349]	Children with ASD diagnosis (criteria not given, it was only stated as 'confirmed diagnosis of ASD from a specialist clinic') who had a mean age of 2.8 years at start of the study	62 (families)	61	98	–	–	< 4	Years	55	6	Autism
	Osborne 2008[350]	2.6–4 years old with GARS diagnosis of ASD	65	65	100	–	–	2.6–4	Years	59	6	ASD
	Osborne 2009[351]	2.6–4 years old with GARS diagnosis of ASD	65	65	100	3.4	0.75	2.6–4.0	Years	59	6	ASD
	Remington 2007[358]	30–42 months of age with ADI diagnosis of ASD	44	44	100	37	4.2	30–42	Months	NR	NR	Autism or suspected autism
	Rickards 2009[423]	3–5 years, 35/59 diagnosed ASD by DSM-IV criteria	54	54	100	69.65	–	–	Months	43	11	ASD
Questionnaire on Resources and Stress-Friedrich Short Form (QRS-F)	Reed 2013[437]	0	52	52	100	44.4	7.9	36.77	Months	46	6	Childhood autism, PDD-NOS
Reaction to Diagnosis Interview	Oppenheim 2012[461]	45 boys and their mothers	45	45	100	49.35	9.56	32–69	Months	45	0	AD, PDD-NOS
	Wachtel 2008[462]	Mothers of ASD children, aged 18–33 months, diagnosed by ADOS and ADI	63	63	100	32	7.1	20–50	Months	48	15	ASD
Satisfaction with Life Scale	Hsieh 2013[452]	Parents of children with ASD	40	40	100	5	0.9	2.5–6.0	Years	35	5	Autism, PDD-NOS, Asperger
Stress Arousal Checklist	Jocelyn 1998[298]	24- to 72-month-old children who met DSM-III-R criteria	35	35	100	43.2	9.1	–	Months	27	8	Autism, PDD-NOS

Parent stress	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/months	M	F	Diagnosis
Symptom Checklist-90-Revised (SCL-90)	Bennett 2012[304]	Children with ASD aged 2–4 years old	214	178	83	–	–	2–4	Years	181	33	AD, Asperger syndrome, PDD-NOS
Daily occupational experience[a]	Hsieh 2013[452]	Parents of children with ASD	40	40	100	5	0.9	2.5–6.0	Years	35	5	Autism, PDD-NOS, Asperger
Parent–child Interaction Rating Scales[a]	Wachtel 2008[462]	Mothers of ASD children, aged 18–33 months, diagnosed by ADOS and ADI	63	63	100	32	7.1	20–50	Months	48	15	ASD
Parenting stress thermometer[a]	Tonge 2005[456]	Parents of children 2.5–5 years old with DSM-IV diagnosis of ASD	105 (parents)	103	100	–	–	23–70	Months	87	16	AD
Self-constructed questionnaire[a]	Farmer 2013[463]	Children aged 2–6 years; criteria for diagnosis not stated	102	102	100	–	–	2–6	Years	37	65	Autism
Stress thermometer[a]	Herring 2006[411]	Children were aged between 20 and 51 months who met the DSM-IV criteria for diagnosis	123	84	68	37.75	7.07	–	Months	75	9	AD, PDD-NOS

AD, autistic disorder; DSM-IV-TR, *Diagnostic and Statistical Manual of Mental Disorders*-Fourth Edition-Text Revision; F, female; M, male; N/A, not available; NR, not reported; SD, standard deviation.

a Tools developed ad hoc.

Family quality of life	Paper	Participant description	*n*	*n* with ASD	% ASD	Mean age	Age SD	Age range	Years/ months	M	F	Diagnosis
Beach Family Quality of Life Questionnaire	Roberts 2011[405]	2.2–5 years with DSM-IV diagnosis of ASD	95	95	100	–	–	26.3–60.3	Months	86	9	AD, ASD
Family Adaptability and Cohesion Evaluation Scales	Bendixen 2011[458]	Children had a mean age of 4.41 years (SD = 1.36, range = 3–8 years)	19	19	100	4.41	1.36	3–8	Years	18	1	AD
Family Assessment Device	Herring 2006[411]	Children were aged between 20 and 51 months who met the DSM-IV criteria for diagnosis	123	84	68	37.75	7.07	–	Months	75	9	AD, PDD-NOS
	Tonge 2005[456]	Parents of children aged 2.5–5 years old with DSM-IV diagnosis of ASD	105 (parents)	103	100	–	–	23–70	Months	87	16	AD
Family Assessment Measure (Skinner *et al.* 1983)	Jocelyn 1998[298]	24- to 72-month-old children who met DSM-III-R criteria	35	35	100	43.2	9.1	–	Months	27	8	Autism, PDD-NOS
Family Empowerment Scale	Minjarez 2013[459]	2–6 years with DSM-IV-TR criteria	17	17	100	3.11	1.1	2.5–6.7	Years	17	0	AD, PDD-NOS
	Rickards 2009[423]	3–5 years, 35/59 diagnosed ASD by DSM-IV criteria	54	54	100	69.65	–	–	Months	43	11	ASD
Family Support Scale	Rickards 2009[423]	3–5 years, 35/59 diagnosed ASD by DSM-IV criteria	54	54	100	69.65	–	–	Months	43	11	ASD
Kansas Inventory of Parental Perceptions	Remington 2007[358]	30–42 months of age with ADI diagnosis of ASD	44	44	100	37	4.2	30–42	Months	NR	NR	Autism or suspected autism
Parenting Alliance Inventory	Hill-Chapman 2013[434]	Parents of children with ASD	56	56	100	3.98	1.31	–	Years	N/A	N/A	AD, PDD-NOS, Asperger syndrome
Familial Resources Index[a]	Baghdadli 2012[339]	Age < 7 years, ICD-10 diagnosis of autism	280	280	100	4.9	1.3	–	Months	230	50	Childhood autism, atypical autism
TRE-ADD Autism Quiz (TAQ)[a]	Jocelyn 1998[298]	24- to 72-month-old children who met DSM-III-R criteria	35	35	1	43.2	9.1	–	Months	27	8	Autism, PDD-NOS
Family Satisfaction Questionnaire[a]	Smith 2000[413]	18–42 months with 'clinical' diagnosis of ASD	28	28	100	35.92	–	–	Months	23	5	Autism, PDD-NOS

AD, autistic disorder; DSM-IV-TR, *Diagnostic and Statistical Manual of Mental Disorders*-Fourth Edition-Text Revision; F, female; M, male; N/A, not available; NR, not reported; SD, standard deviation.
a Tools developed ad hoc.

Chapter 3 Tools used (subscales, outcomes measured)

Symptom severity	Paper	Subscales used	Outcome(s) measured according to the author
Autism Behavior Checklist (AuBC)	Bennett 2008[296]	–	Clinical diagnosis at different time points
	Gupta 2009[303]	Total, sensory, relating, body/object use, language/social, self-help behaviours	Sensory, relating, body/object use, language/social, self-help
	Jocelyn 1998[298]	Sensory, relating, body/object use, language/social, self-help behaviours	–
	Silva 2007[299]	–	'Non-adaptive behaviours'
	Silva 2008[300]	–	'Autistic behaviour'
	Silva 2009[300]	–	'Autistic behaviour'
	Silva 2011[301]	–	'Autistic behaviour'
	Szatmari 2000[302]	–	'Pervasive developmental disorder symptoms'
	Zhang 2012[303]	–	Typical autistic behaviours
Autism Diagnostic Interview-Revised (ADI-R)	Bennett 2012[304]	Non-verbal items were used so that results could be compared between verbal and non-verbal children	–
	Ben Itzchak 2008[149]	–	Autism severity
	Brian 2008[305]	–	–
	Feldman 2012[104]	–	–
	Hambly 2012[306]	Items on language (#42, 46, 29, 30, 9, 10)	Sociocommunicative levels, ages of early language milestones
	Honey 2008[307]	Repetitive behaviour algorithm items	'Repetitive behaviour'
	Magiati 2007[308]	–	Autism severity and diagnosis confirmation
	Magiati 2011[309]	Total score	Autism severity
	Mayo 2013[310]	–	Communication, social development and play, and the presence of repetitive or restricted behaviours
	Mooney 2006[311]	–	'Repetitive behaviours'
	Munson 2008[312]	Social relatedness, communication, repetitive, restricted behaviours	'Autism severity'
	Ozonoff 2010[313]	–	'Parent recall of symptom onset and possible regression'
	Pry 2005[314]	–	'Expressive language level'
	Richler 2007[315]	Restricted and repetitive behaviours items	'Restricted and repetitive behaviours'
	Werner 2005[316]	Social, communication, repetitive	'Developmental outcomes'

Symptom severity	Paper	Subscales used	Outcome(s) measured according to the author
Autism Diagnostic Observation Scale-Toddler Module (ADOS-T)	Rogers 2012[317]	Social affect, restricted, repetitive behaviours	'Social and communicative behaviours, as well as repetitive behaviours diagnostic of autism'
Autism Diagnostic Observation Schedule (ADOS)	Aldred 2004[318]	Reciprocal social interaction, communication, stereotyped and restricted behaviours	'Interaction, communication, repetitive behaviours and play'
	Aldred 2012[319]	Total social communication algorithm score	Social communication
	Ben Itzchak 2008[149]	Language and communication, reciprocal social interaction, play, and stereotyped behaviour and restricted interests	Social and communicative functioning
	Ben Itzchak 2011[320]	ADOS standardised measure of severity	Autism severity, diagnostic algorithm
	Bennett 2012[304]	–	Social and communication behaviours
	Brian 2008[305]	Module 1	–
	Dawson 2010[321]	Social relatedness, communication, play, repetitive behaviours	'Autism symptoms'
	Gotham 2012[322]	–	Symptom severity
	Green 2010[253]	Communication, social	'Severity of the symptoms of autism'
	Hartley 2009[323]	Communication, social interaction, restricted behaviours	ASD symptoms
	Landa 2012[224]	–	Symptom severity
	Lerna 2012[325]	Communication, reciprocal social interaction	Social communicative abilities
	Luyster 2008[129]	Play	–
	Munson 2008[312]	Communication, social	'Autism severity'
	Oosterling 2010[326]	Level of non-echoed language, joint attention, social affect	Language development, early precursors of social communication
	Ray-Subramanian 2011[327]	–	'Social communication skills and behaviours characteristic of autism'
	Ray-Subramanian 2012[328]	Calibrated ADOS severity scores, composite RRB variable	RRB
	Strauss 2012[329]	Communication, social	'Severity of autism symptoms'
	Sullivan 2007[330]	Response to joint attention item	'Response to joint attention'
	Tek 2012[331]	Communication, reciprocal social interaction	Assessment for ASD
	Ventola 2007[332]	Communication, social	'Communication, social interactions and relatedness, play, and imagination'
	Werner 2005[316]	Communication, social	'Developmental outcomes'

Symptom severity	Paper	Subscales used	Outcome(s) measured according to the author
	Wong 2010[333]	Language and communication, reciprocal social interaction	'Assessing Autism Spectrum Disorder'
	Zachor 2006[334]	Language and communication, reciprocal social interaction	Language and communication and reciprocal social interaction
	Zachor 2010[335]	–	'Autism severity'
Autism Observation Scale for Infants (AOSI)	Brian 2008[305]	–	'Putative signs of autism in infants aged 6 to 18 months'
	Bryson 2008[81]	–	–
Baby and Infant Screen for Children with aUtIsm Traits (BISCUIT-Part 1)	Fodstad 2009[342]	–	ASD symptoms
Behavioral Summarized Evaluation (BSE)-Revised	Receveur 2005[337]	–	'Interaction disorders'
Behavioral Summarized Evaluation (BSE)	Maestro 2005[344]	–	'Severity of behavioural problems'
Childhood autism Rating Scale (CARS)	Baghdadli 2012[339]	–	Symptom severity
	Bopp 2009[340]	–	Autism severity
	Jonsdottir 2007[341]	–	Behaviour
	Malhi 2011[342]	–	Severity of autism symptom
	Mayo 2013[310]	–	Presence and severity of symptoms of ASD
	Pajareya 2012[343]	–	Degree of autistic symptoms
	Pajareya 2011[344]	–	'Degree of autistic symptoms'
	Papavasiliou 2011[345]	–	'Severity of autistic behaviour'
	Pry 2005[314]	–	'Severity of autistic symptoms'
	Stone 1999[346]	–	Autism characteristics
	Ventola 2007[332]	–	'Presence and severity of pervasive developmental disorders'
	Vorgraft 2007[347]	–	'Interactive behaviour . . . degree of autism'
	Zhang 2012[303]	–	'Behaviours that are generally affected by severe autism'
Gilliam Autism Rating Scale (GARS)	Cassidy 2008[348]	Stereotyped behaviors, communication, social interaction, developmental disturbances	'Features of autism'
	McConkey 2010[349]	–	Autism features such as stereotyped behaviours, communication, social interaction and developmental disturbances
	Osborne 2008[350]	Stereotyped behaviors, communication, social interaction, developmental disturbances	'Behaviours symptomatic of autism'
	Osborne 2009[351]	Stereotyped behaviors, communication, social interaction, developmental disturbances	'Autism severity'

Symptom severity	Paper	Subscales used	Outcome(s) measured according to the author
	Reed 2007[352]	Stereotyped behaviors, communication, social interaction, developmental disturbances	'Autism severity'
	Reed 2007[353]	Stereotyped behaviors, communication, social interaction, developmental disturbance	'Autism severity'
	Reed 2012[354]	Stereotyped behaviors, communication, social interaction, developmental disturbances	Severity of autism
	Stahmer 2004[355]	–	Severity of autistic symptoms
Infant Behavioral Summarized Evaluation (IBSE)	Adrien 1992[90]	–	General autism characteristics
	Receveur 2005[337]	–	'Early signs of autism' and 'behavioural evaluation'
Modified Checklist for Autism in Toddlers (M-CHAT)	Ventola 2007	–	'Joint attention, interest in other children, responding to name, and imitation'
Parent Observation of Early Markers Scale (POEMS)	Feldman 2012[104]	–	Social and communicative development, restricted interests, ritualistic, repetitive non-functional behaviours
Pervasive Developmental Disorder Rating Scale (PDDRS)	Eaves 2006[356]	Arousal, affect, cognition	The construct of autism through three scales
Pervasive Developmental Disorders Behavior Inventory (PDDBI)	Silva 2009[226]	Receptive/expressive social communication abilities composite, approach/withdrawal problems composite, sensory	'Social and language abilities and maladaptive behaviour'
	Silva 2011[301]	Sensory, maladaptive behaviour, social/language/communication abilities	'Social and language abilities and maladaptive behaviour'
Real Life Rating Scale (Ritvo–Freeman) (RLRS)	Wong 2010[333]	Sensory motor behaviour, social relationship to people, affectual reaction, sensory response, language	'Parents' perception of their children's social and communication behaviour'
Social Communication Questionnaire (SCQ)	Eapen 2013[357]	–	Communication behaviours
	Remington 2007[358]	–	'Autism symptoms'
Social Responsiveness Scale (SRS)	Bennett 2012[304]	–	ASD symptoms or behaviours
	Hambly 2012[306]	–	Severity of autism symptoms within children's natural environments (Constantino 2002)
	Smith 2010[359]	–	'Autism symptoms'
Childhood autism rating scale-Tokyo version[a]	Takeda 2005[360]	–	'Autistic symptoms'

a Non-UK.

Social awareness	Paper	Subscales used	Outcome(s) measured according to the author
Child Behaviour Rating Scale (CBRS) (Modified)	Casenhiser 2013[361]	–	Child behaviour
Communication and Symbolic Behavior Scales-Developmental Profile (CSBS-DP)	Green 2010[253]	Social composite	'Child social communication'
	Landa 2007[368]	Gaze shifts, shared positive affect, response to joint attention bids, initiation of joint attention, initiation of behaviour regulation, inventory of gestures, consonants in syllables, words and word combinations, action schema inventory, action schema sequences, action schema towards others	'Communicative, social affective, and symbolic abilities'
	Sullivan 2007[330]	Gaze-point following variable	'Response to joint attention . . . look and point trial'
	Keen 2010[363]	–	Social communication, speech and symbolic behaviour
	Keen 2007[364]	Social, speech, symbolic	Social, speech and symbolic abilities
Early Social Communication Scale (ESCS)	Dereu 2012[365]	–	Initiating joint attention, responding to joint attention
	Goods 2013[366]	Spontaneous requesting gestures	Spontaneous requesting gestures
	Ingersoll 2012[286]	–	Social interaction
	Kaale 2012[294]	–	Joint attention
	Kalas 2012[367]	–	Responses to bids for joint attention
	Kasari 2006[368]	–	Social communication
	Lawton 2012[369]	–	Joint attention, social interaction, symbolic play and behaviour regulation
	Luyster 2008[129]	Initiating joint attention, responding to joint attention	–
	Paparella 2011[370]	–	'Initiations and responses of joint attention behaviours'
	Remington 2007[358]	Initiating joint attention, responding to joint attention	'Non-verbal social communication'
	Roos 2008[371]	Initiating joint attention, responding to joint attention	'Joint attention'
	Salt 2002[372]	Joint attention, requesting, social interaction	'Non-verbal social communication'
	Wong 2013[373]	–	Non-verbal initiations and responses to joint attention, behaviour regulation or requesting behaviours, and social interactions
	Yoder 2006[374]	Communication	–

Social awareness	Paper	Subscales used	Outcome(s) measured according to the author
Early Social Communication Scales (ESCS)-Abridged	Yoder 2010[375]	–	'Number of picture exchanges at post treatment assessment'
Imitation Battery (IB)	Luyster 2008[129]	–	–
Imitation Disorders Evaluation (IDE)	Receveur 2005[337]	–	'Deficient and atypical imitation'
Motor Imitation Scale (MIS)	Ingersoll 2010[376]	–	Ability of child to imitate in a structured and elicited context
	Ingersoll 2012[286]	–	Imitation
Preschool Imitation and Praxis Scale (PIPS)	Dereu 2012[365]	Subscales for bodily imitation and procedural imitation were used	Motor imitation abilities
Pre-Verbal Communication Schedule (PVCS)	Salt 2002[372]	Motor imitation subscale, social imitation subscale	'Imitation'
Social Communication Assessment for Toddlers with Autism (SCATA)	Drew 2007[137]	–	Social communication (contexts: free play, turn-taking, activated musical toys, bubbles, specific prompts)
Social Communication Behavior Codes	Ozonoff 2010[313]	Gaze to faces, gaze to objects, smiles, non-verbal vocalisations, single word verbalisations, phrase verbalisations	'Social communication behaviour'
Parent interview[a]	Clifford 2008[377]	Gaze, affect, joint attention, requesting	'Parent's perception of their child's early behaviours'
Caregiver–child interaction[b]	Kasari 2006[368]	–	Functional play acts, play levels, joint attention skills, joint engagement
Coded observation of joint attention[b]	Warreyn 2007[384]	Initiating requesting, following declarative, initiating declarative	'Joint attention'
Coding of initiation of joint attention[b]	Ingersoll 2012[286]	–	Initiation of joint attention
Classroom observation measure (Wong and Kasari 2012)[b]	Goods 2013[366]	–	Engagement states, spontaneous communicative gesture
Examiners Ratings of Social Engagement[b]	Ozonoff 2010[313]	Frequency of eye contact, frequency of shared affect, overall social responsiveness	'Social engagement'
Naturalistic examiner–child play sample[b]	Roos 2008[371]	Initiating joint attention, responding to joint attention	'Joint attention'
Prelinguistic Communication Assessment[b]	Stone 1997[135]	–	'Non-verbal communication'
Preschool teacher–child play[b]	Kaale 2012[294]	–	Joint attention and joint engagement

Social awareness	Paper	Subscales used	Outcome(s) measured according to the author
Unstructured free play with examiner[b]	Lerna 2012[325]	–	Co-operative play, joint attention, requests labelling
Unstructured Imitation Assessment[b]	Ingersoll 2012[286]	–	Imitation
	Ingersoll 2010[376]	–	Child's ability to imitate in a spontaneous, social-interactive context
Video coding procedures[b]	Colgan 2006[379]	–	Communicative gestures
Video observation[b]	Clifford 2008[377]	Gaze, affect, joint attention, requesting	'Early social deficits'
Video rating for expressive speech[b]	Baghdadli 2012[339]	–	Expressive speech
Video recording of child in classroom activites[b]	Ingersoll 2001[380]	Language, peer social avoidance	Peer social avoidance behaviour, language

CLT, Conventional Language Therapy; PECS, Picture Exchange Communication System.
a Tools developed ad hoc.
b Observational coding.

Restricted, repetitive behaviour	Paper	Subscales used	Outcome(s) measured according to the author
	Ben Itzchak 2008[149]	–	Autism severity
Autism Diagnostic Interview-Revised (ADI-R)	Bennett 2012[304]	Non verbal items were used so that results could be compared between verbal and non-verbal children	–
	Brian 2008[305]	–	–
	Feldman 2012[104]	–	–
	Hambly 2012[306]	Items on language (#42, 46, 29, 30, 9, 10)	Sociocommunicative levels, ages of early language milestones
	Honey 2008[307]	Repetitive behaviour algorithm items	'Repetitive behaviour'
	Magiati 2007[308]	–	Autism severity and diagnosis confirmation
	Magiati 2011[309]	Total score	Autism severity
	Mayo 2013[310]	–	Communication, social development and play, and the presence of repetitive or restricted behaviours
	Mooney 2006[311]	–	'Repetitive behaviours'
	Munson 2008[312]	Social relatedness, communication, repetitive, restricted behaviours	'Autism severity'
	Ozonoff 2010[313]	–	'Parent recall of symptom onset and possible regression'
	Pry 2005[314]	–	'Expressive language level'
	Richler 2007[315]	RRB items	'Restricted and repetitive behaviours'
	Werner 2005[316]	Social, communication, repetitive	'Developmental outcomes'
Autism Diagnostic Observation Scale-Toddler Module (ADOS-T)	Rogers 2012[317]	Social affect, restricted, repetitive behaviours	'Social and communicative behaviours, as well as repetitive behaviours diagnostic of autism'
Autism Diagnostic Observation Schedule-Generic (ADOS-G) – Modules 1 and 2)	Green 2010[253]	Communication, social	'Severity of the symptoms of autism'
Autism Diagnostic Observation Schedule-Generic (ADOS-G)	Aldred 2004[318]	Reciprocal social interaction, communication, stereotyped and restricted behaviours	'Interaction, communication, repetitive behaviours and play'
	Aldred 2012[319]	Total social communication algorithm score	Social communication
	Ben Itzchak 2008[149]	Language and communication, reciprocal social interaction, play, and stereotyped behaviour and restricted interests	Social and communicative functioning
	Ben Itzchak 2011[320]	ADOS standardised measure of severity	Autism severity, diagnostic algorithm
	Bennett 2012[304]	–	Social and communication behaviours

Restricted, repetitive behaviour	Paper	Subscales used	Outcome(s) measured according to the author
	Brian 2008[305]	Module 1	–
	Dawson 2010[321]	Social relatedness, communication, play, repetitive behaviours	'Autism symptoms'
	Gotham 2012[322]	–	Symptom severity
	Hartley 2009[323]	Communication, social interaction, restricted behaviours	ASD symptoms
	Landa 2012[224]	–	Symptom severity
	Lerna 2012[325]	Communication, reciprocal social interaction	Social communicative abilities
	Luyster 2008[129]	Play	–
	Munson 2008[312]	Communication, social	'Autism severity'
	Oosterling 2010[326]	Level of non-echoed language, joint attention, social affect	Language development, early precursors of social communication
	Ray-Subramanian 2011[327]	–	'Social communication skills and Behaviours characteristic of autism'
	Ray-Subramanian 2012[328]	Calibrated ADOS severity scores, composite RRB variable	RRB
	Strauss 2012[329]	Communication, social	'Severity of autism symptoms'
	Sullivan 2007[330]	Response to joint attention item	'Response to joint attention'
	Tek 2012[331]	Communication, reciprocal social interaction	Assessment for ASD
	Ventola 2007[332]	Communication, social	'Communication, social interactions and relatedness, play, and imagination'
	Werner 2005[316]	Communication, social	'Developmental outcomes'
	Wong 2010[333]	Language and communication, reciprocal social interaction	'Assessing autism spectrum disorder'
	Zachor 2006[334]	Language and communication, reciprocal social interaction	Language and communication and reciprocal social interaction
	Zachor 2010[335]	–	'Autism severity'
Repetitive Behavior Scale (RBS)	Dawson 2010[321]	–	'Severity of repetitive behaviours'
Classroom and playground behaviour observations[a]	Escalona 2001[271]	–	Positive response to touch, on-task behaviour, stereotypical behaviour, social relatedness to the teacher
Video coding[a]	Barber 2012[381]	–	Repetitive and stereotyped behaviours (RSB)

a Observational coding.

Sensory processing	Paper	Subscales used	Outcome(s) measured according to the author
Infant/Toddler Sensory Profile (ITSP)	Ben-Sasson 2008[382]	Low registration (sensory under responsivity), sensation seeking, sensory sensitivity, sensation avoiding, sensory over responding (sum of sensitivity and avoiding)	'Sensory processing behaviours in daily experiences'
Sense and Self-Regulation Checklist (SSC)	Silva 2009[226]	–	'Parent questionnaire (on) changes in sensory impairment, appetite, digestion, and sleep'
	Silva 2011[301]	Sense, self-regulation	'Sensory and self-regulatory symptoms commonly reported by parents'
Sensory Profile (SP)	Chuang 2012[383]	–	Sensory events
	Jasmin 2009[384]	–	Sensory processing, modulation, behavioural and emotional responses
	Provost 2009[385]	Sensory processing area, modulation area, behavioural and emotional responses area	'Sensory behaviours'
	Silva 2007[299]	Sensory processing section, modulation section, behaviour and emotional responses, sensory factor scale	'Children's responses to commonly occurring sensory experiences'
	Silva 2008[300]	Sensory processing, modulation, behaviour and emotional responses	'Child's sensory processing abilities'
Short Sensory Profile (SSP)	O'Donnell 2012[386]	Tactile sensitivity, taste/smell sensitivity, movement sensitivity, under-responsive/ seeks sensation, auditory filtering, low energy/weak, visual/auditory sensitivity	'Sensory processing difficulties and associated behaviours'
	Papavasiliou 2011[345]	–	'Children's response capability to sensory and behavioural/ emotional stimuli and daily performance'
	Tomchek 2007[387]	–	'Atypical sensory processing'

Language	Paper	Subscales used	Outcome(s) measured according to the author
Autism Screening Instrument for Educational Planning (ASIEP)	Arick 2003[388]	Autism behavior checklist, sample of vocal behavior, social interaction assessment, educational assessment	Educational progress
Battelle Developmental Inventory (BDI)	Arick 2003[388]	–	Conceptual skills and abilities
British Picture Vocabulary Scale	Magiati 2007[308]	–	Receptive and expressive language
	Magiati 2011[309]	–	Language comprehension
Clinical Evaluation of Language Fundamentals-Revised	Bono 2004[389]	–	'Language abilities'
Communication and Symbolic Behavior Scales-Developmental Profile (Caregiver Questionnaire) CSBS-DP (CQ)	Tek 2012[331]	CSBS-DP CQ Words, CSBS-DP CQ Understanding Words, CSBS-DP CQ Social Composite	Language and social development
Comprehensive Assessment of Spoken Language (CASL)	Casenhiser 2013[361]	–	Language – receptive and expressive
Expressive One-Word Picture Vocabulary Test	Arick 2003[388]	–	English vocabulary
	Bopp 2009[340]	–	Expressive vocabulary
	Magiati 2007[308]	–	Receptive and expressive language
	Magiati 2011[309]	–	Expressive language
Illinois Test of Psycholinguistic Abilities	Carlsson 2013[390]	–	Language – expressive and receptive
MacArthur–Bates Communicative Development Inventories (MCDI)	Aldred 2004[318]	Language comprehension, expressive language	'Understanding and expression of words and gestures'
	Green 2010[253]	–	'Child language and social communication'
	Hambly 2012[306]	Words and sentences	Vocabulary
	Hudry 2010[233]	Receptive (words understood), expressive (words understood and said)	'Receptive and expressive language skills'
	Luyster 2008[129]	Expressive, receptive, gestures	Early language abilities
	Miniscalco 2012[391]	Early words, handling and gestures	'Expressive and comprehension skills' and 'development of early communicative gestures'
	Mitchell 2006[392]	Phrases understood, vocabulary comprehension, vocabulary production, early gestures, late gestures	'Assessment of language development'
	Oosterling 2010[326]	Language, gestures	Language development, early precursors of social communication
	Rogers 2012[317]	Phrases understood, vocabulary comprehension, vocabulary production, total gestures	Expressive words, gestures and receptive vocabulary
	Salt 2002[372]	Words understood, words produced	'Receptive and expressive language'

Language	Paper	Subscales used	Outcome(s) measured according to the author
	Smith 2007[393]	–	'Prelinguistic and early language development'
	Smith 2010[359]	–	'Language/communication'
	Stone 2001[394]	–	'Expressive language'
	Strauss 2012[329]	Comprehension, production	'Vocabulary comprehension and vocabulary production'
Mullen Scales of Early Learning (MSEL)	Akshoomoff 2006[395]	Visual reception, fine motor, receptive language, expressive language	'Cognitive Ability . . . separate scores for verbal and non-verbal skills'
	Anan 2008[396]	Visual reception, fine motor, receptive language, expressive language	Cognitive functioning
	Baker 2010[397]	Expressive language, receptive language	'Language ability'
	Barbaro 2012[398]	Visual perception, fine motor, receptive language, expressive language	Developmental status
	Ben Itzchak 2011[320]	Visual reception, fine motor, expressive language, language comprehension	Cognitive abilities
	Bishop 2011[176]	Non-verbal, verbal	Intellectual development (non-verbal and verbal IQ)
	Brian 2008[305]	Composite (visual reception, receptive, expressive, fine motor)	Cognitive ability
	Dawson 2010[321]	Fine motor, receptive language, expressive language, visual problem-solving	'Fine motor, visual reception, expressive language, and receptive language'
	Dereu 2012[365]	Age equivalents	General development
	Eapen 2013[357]	–	Early development
	Hartley 2009[323]	Visual reception, fine motor, receptive language, expressive language	Cognitive development
	Honey 2008[307]	Receptive language, expressive language	'Children's abilities'
	Landa 2012[399]	Gross motor, fine motor, visual reception, receptive language, expressive language	'Development'
	Landa 2012[224]	–	IQ
	Lloyd 2013[400]	Gross motor, fine motor, visual reception, receptive language, expressive language	IQ, gross and fine motor skills
	Luyster 2008[129]	Receptive language, expressive language, visual reception, fine motor skill	Language ability
	Mayo 2013[310]	Gross motor, fine motor, visual reception, receptive language, expressive language	Cognitive development
	Mitchell 2006[392]	–	'Expressive and receptive language skills'

Language	Paper	Subscales used	Outcome(s) measured according to the author
	O'Donnell 2012[386]	Visual reception, receptive language, expressive language, fine motor	'Cognitive functioning'
	Ozonoff 2010[313]	Fine motor, receptive language, expressive language, visual problem solving	'Cognitive functioning'
	Poon 2012[401]	–	'Intellectual abilities'
	Ray-Subramanian 2012[328]	Visual reception raw scores	Non-verbal cognition
	Rogers 2012[317]	Receptive language, expressive language, visual reception, fine motor skill	An overall index of ability
	Schertz 2013[402]	Receptive language, expressive language	Cognitive functioning
	Siller 2013[403]	Expressive language	Non-verbal cognitive and language abilities
	Sullivan 2007[330]	Gross motor, fine motor, visual reception, receptive language, expressive language	'Overall cognitive development'
	Tek 2012[331]	Visual reception, expressive language, receptive language, fine motor, gross motor	Comprehensive assessment of development
	Thurm 2007[404]	Receptive language organisation, expressive language organisation	'Language ability'
	Toth 2006[284]	Receptive language, expressive language	'Receptive and expressive language'
	Ventola 2007[332]	Fine motor, receptive language, expressive language, visual problem solving	'Ability'
	Werner 2005[316]	Composite IQ, verbal IQ	'Developmental outcomes'
	Zachor 2010[335]	Visual reception, fine motor, expressive language, receptive language	'Non-verbal cognitive measure . . . and verbal measure'
Pragmatics Profile	Roberts 2011[405]	–	'Communication'
Preschool Language Scale (PLS)	Bopp 2009[340]	Auditory comprehension, expressive communication	Language skills
	Casenhiser 2013[361]	–	Language – receptive and expressive
	Flippin 2011[406]	Auditory comprehension, expressive communication	Language skills
	Green 2010[253]	–	'Child language and social communication'
	Haebig 2013[407]	–	Receptive and expressive communication
	Harris 1991[408]	–	Language development
	Hudry 2010[233]	Receptive language, expressive language	'Receptive and expressive language skills'
	Mitchell 2006[392]	–	'Expressive and receptive language skills'

Language	Paper	Subscales used	Outcome(s) measured according to the author
	Ray-Subramanian 2012[328]	Auditory comprehension, expressive communication	Understanding of language, ability to communicate
	Smith 2010[359]	Receptive language, expressive language	'Language/communication'
	Stone 2001[394]	–	'Language comprehension'
Reynell Developmental Language Scales	Andersson 2013[409]	–	Language comprehension
	Bono 2004[389]	Comprehension, expression	'Language abilities'
	Carlsson 2013[390]	–	Language – receptive and expressive
	Eikeseth 2009[410]	–	'Language functioning'
	Goods 2013[366]	Verbal comprehension, expressive language	Verbal comprehension, expressive language
	Herring 2006[411]	–	Language ability
	Miniscalco 2012[391]	Comprehension, language production	'Combined comprehension and language production test'
	Remington 2007[358]	–	'Language'
	Roberts 2011[405]	–	'Communication'
	Sheinkopf 2000[412]	–	'Expressive language ability'
	Smith 2000[413]	Comprehension, expressive language	'Language functioning'
Sequenced Inventory of Communication-Revised	Stone 2001[394]	–	'Receptive and expressive language'
Test for Auditory Comprehension of Language	Szatmari 2000[302]	Grammatic morphemes subtest	'Child's understanding of grammatic structures'
Test of Language Development	Bennett 2008[296]	Grammatic completion, grammatic understanding	Grammatical comprehension and usage
	Szatmari 2000[302]	Grammatic understanding subtest, grammatic completion subtests	'Grammatic comprehension and usage'
Vineland Adaptive Behavior Scales (VABS)	Aldred 2004[318]	Communication, DLS, socialisation	'Communication, daily living skills, and socialisation'
	Anan 2008[396]	Communication, DLS, socialisation, motor skills	Adaptive functioning
	Andersson 2013[409]	–	Adaptive skills
	Arick 2003[388]	–	Adaptive behaviour
	Baghdadli 2012[339]	Communication, DLS, socialisation	Adaptive behaviours
	Bearss 2013[278]	–	Communication, DLS, socialisation, motor skills
	Ben Itzchak 2011[320]	Communication, DLS, socialisation, motor skills	Adaptive skills
	Bennett 2008[296]	Social, communication, DLS	Personal and social sufficiency
	Carlsson 2013[390]	Motor Skills domain	Motor function
	Cassidy 2008[348]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'

Language	Paper	Subscales used	Outcome(s) measured according to the author
	Dawson 2010[321]	Communication, DLS, socialisation, motor skills	'Social, communication, motor, and daily living skills'
	Eapen 2013[357]	–	Communication – expressive and receptive, DLS, socialisation, motor skills
	Eikeseth 2009[410]	–	'Adaptive behaviours'
	Eldevik 2012[414]	Adaptive behaviour composite, communication, daily living, socialisation	Adaptive behaviour
	Eriksson 2013[415]	–	Adaptive skills
	Gabriels 2007[416]	Communication, DLS, socialisation, motor skills, adaptive behaviour composite	Adaptive behaviour skills
	Green 2010[253]	–	'Adaptive functioning in school beyond the family'
	Grindle 2012[417]	–	Adaptive skills, socialisation, communication, DLS, motor skills
	Hedvall 2013[418]	Communication, DLS, socialisation, motor skills	–
	Herring 2006[411]	Derived Adaptive Behaviour Composite (ABC) standard score	Adaptive behaviour
	Honey 2008[307]	Communication, socialisation	'Children's abilities'
	Hudry 2010[233]	Receptive language, expressive language	'Receptive and expressive language skills'
	Jasmin 2009[384]	DLS	DLS
	Jonsdottir 2007[341]	Composite	Adaptive behaviour in communication, DLS, socialisation and motor skills
	Klintwall 2012[419]	–	'Treatment gains . . . treatment outcomes'
	Landa 2012[224]	Communication domain standard score	Communication skills
	Lerna 2012[325]	–	Child communication, social abilities
	Lloyd 2013[400]	Communication, DLS, socialisation, motor skills	Communication, DLS, social skills, motor development
	Luyster 2008[129]	Motor, communication	Children's personal and social sufficiency in communication (receptive, expressive, written), DLS (personal, domestic, community), socialisation (interpersonal relationships, play and leisure, time, coping skills), and motor skills (gross, fine)
	Magiati 2007[308]	Communication, DLS, socialisation	Adaptive behaviour
	Magiati 2011[309]	Communication, DLS, socialisation, composite	Adaptive behaviour

Language	Paper	Subscales used	Outcome(s) measured according to the author
	Mayo 2013[310]	Communication, DLS, socialisation, motor skills	Adaptive functioning
	McConkey 2010[349]	Communication, DLS, socialisation, motor skills	Communication, DLS, socialisation and motor skills
	Munson 2006[420]	Socialisation, communication	'Socialisation and communication skills'
	Munson 2008[312]	Social, communication, DLS, motor skills	'Adaptive behaviours'
	O'Donnell 2012[386]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Osborne 2008[350]	Communication, DLS, socialisation, motor skills	'Day-to-day adaptive functioning'
	Osborne 2009[351]	Communication, DLS, socialisation, motor skills	'Adaptive behavioural functioning'
	Peters-Scheffer 2010[421]	Communication, DLS, socialisation	'Adaptive behaviour'
	Poon 2012[401]	Communication	'Communication'
	Pry 2005[314]	Communication, DLS, socialisation	'Child's knowledge about the social norms, conventions, and scripts that govern social life at all levels'
	Ray-Subramanian 2011[327]	Communication, DLS, socialisation, motor skills	'Adaptive skills'
	Reed 2007[352]	Communication, DLS, socialisation, motor skills	'Adaptive functioning'
	Reed 2007[353]	Communication, DLS, socialisation, motor skills	'Adaptive functioning'
	Reed 2012[354]	Communication, DLS, socialisation, motor skills	Day-to-day adaptive behaviour
Vineland Adaptive Behavior Scales (VABS)	Remington 2007[358]	Socialisation, communication, DLS, motor skills	'Adaptive skills'
	Restall 1994[422]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Rickards 2009[423]	–	'Communication, daily living skills, socialisation and motor skills'
	Roberts 2011[405]	–	'Communication and social skills'
	Rogers 2012[317]	Communication, DLS, socialisation, motor skills	Adaptive behaviour
	Ruble 2008[424]	Socialisation, communication	'Adaptive functioning'
	Salt 2002[372]	Communication, DLS, socialisation, motor skills	'Communication, daily living skills, socialisation and motor skills'
	Schertz 2013[402]	Communication	Adaptive behaviour
	Silva 2007[299]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Silva 2008[300]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'

Language	Paper	Subscales used	Outcome(s) measured according to the author
	Smith 2000[413]	Communication, DLS, socialisation	'Adaptive functioning'
	Smith 2010[359]	Communication, DLS, socialisation, motor skills	'Language/communication', 'adaptive behaviour'
	Stahmer 2004[355]	Communication, DLS, socialisation, motor skills	Child adaptive functioning
	Stone 1999[346]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Strauss 2012[329]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour functioning'
	Szatmari 2000[302]	Socialisation, communication	'Social skills' and 'language'
	Tonge 2012[425]	–	Adaptive behaviour
	Toth 2006[284]	Communication	'Communication skills'
	VanMeter 1997[426]	Communication, DLS, socialisation	'Social, communication, and daily living skills'
	Ventola 2007[332]	Socialisation, communication, DLS, motor skills	'Adaptive functioning'
	Werner 2005[316]	Communication, DLS, socialisation, motor skills	'Developmental outcomes'
	Zachor 2010[335]	Communication, DLS, socialisation, motor skills	'Adaptive functioning'
Vineland Adaptive Behavior Scales-Classroom version (VABS-Classroom)	Goin-Kochel 2007[427]	Communication, DLS, socialisation, motor skills	Communication skills, DLS, socialisation skills, motor skills
Differential Ability Scales[a]	Bishop 2011[176]	Non-verbal IQ, Verbal IQ	–
	Ruble 2008[424]	–	'Cognitive functioning'
	Thurm 2007[404]	Verbal comprehension subtest, naming vocabulary subtest	'Receptive language'
Peabody Picture Vocabulary Test[a]	Bopp 2009[340]	–	Receptive vocabulary skills
	Smith 2010[359]	–	'Language/communication', 'adaptive behaviour'
	Szatmari 2000[302]	–	'Single word comprehension'
Processability test[b]	Carlsson 2013[390]	–	Language (grammar screening)
Rating of video for expressive speech[c]	Baghdadli 2012[339]	–	Expressive speech
Semistructured free play with examiner[c]	Yoder 2006[428]	Non-imitative spoken communication acts, different non-imitative words	'Spoken communication'
Video coding procedures[c]	Colgan 2006[379]	–	Communicative gestures

DLS, daily living skills.
a Non-UK.
b Tools developed ad hoc.
c Observational coding.

Cognitive ability	Paper	Subscales used	Outcome(s) measured according to the author
Battelle Developmental Inventory (BDI)	Arick 2003[388]	–	Conceptual skills and abilities
	Ben Itzchak 2008[149]	–	Cognitive ability
	Eikeseth 2009[410]	–	'Intellectual functioning'
	Eldevik 2012[414]	–	Intellectual functioning
	Grindle 2012[417]	–	IQ
	Ingersoll 2012[286]	The Social–Emotional Scale	Social and emotional development
	Jonsdottir 2007[341]	–	Developmental level
	Magiati 2007[308]	–	Cognitive ability and mental age
	Peters-Scheffer 2010[421]	–	'Developmental age and mental development index'
	Ray-Subramanian 2011[327]	Cognitive scale	'Cognitive skills'
	Remington 2007[358]	–	'Intellectual functioning'
	Rickards 2009[423]	Mental development index (MDI), behaviour rating scale	'Cognition', 'behaviour'
	Sheinkopf 1998[429]	–	'Cognitive measure'
	Smith 1997[430]	Mental development quotient	IQ
	Smith 2000[413]	–	'Intellectual functioning'
	Stahmer 2004[355]	Mental development quotient	Change in child intellectual functioning'
	Ventola 2007[332]	–	'Mental and psychomotor development'
	Zachor 2006[334]	–	Mental Developmental Index
Behavior Rating Inventory of Executive Function (BRIEF)-Preschool Version	Jahromi 2013[431]	Inhibitory Self-Control Index	Executive function
British Ability Scale (BAS)	Osborne 2008[350]	Verbal comprehension, early number concepts, picture matching, naming vocabulary	'Cognitive abilities'
	Osborne 2009[351]	Verbal comprehension, early number concepts, picture matching, naming vocabulary	'Intellectual functioning'
	Reed 2007[352]	Verbal comprehension, early number concepts, picture matching, naming vocabulary	'Cognitive ability'
	Reed 2007[353]	Verbal comprehension, early number concepts, picture matching, naming vocabulary	'Cognitive ability . . . educational achievement'
	Reed 2012[354]	Early Years Battery, verbal comprehension, early number concepts, picture matching, naming vocabulary	Educational achievement
Cattell Infant Intelligence	Sheinkopf 1998[429]	–	'Cognitive measure'

Cognitive ability	Paper	Subscales used	Outcome(s) measured according to the author
Developmental Profile	Malhi 2011[342]	Academic	Developmental assessment; developmental quotient was derived from the academic subscale
Griffiths Mental Developmental Scales	Andersson 2013[409]	–	Developmental quotient
	Carlsson 2013[390]	–	Cognitive/intellectual function
	Hedvall 2013[418]	–	Intelligence/mental age
	Lerna 2012[325]	Language subscale, personal–social	Receptive language, expressive language, activities of daily living, level of independence, interaction with other children
	Strauss 2012[329]	–	'Mental developmental state'
Leiter International Performance Scale-Revised (Leiter-R)	Gabriels 2007[416]	Figure ground, form completion, sequential order, repeated patterns	Intelligence levels
	Grindle 2012[417]	–	IQ
Leiter Performance Scales (Arthur adaptation)	Bennett 2008[296]	–	Non-verbal problem solving or IQ
McCarthy Scales of Children's Abilities	Szatmari 2000[302]	Oral vocabulary section	'Child's language fluency'
Merrill–Palmer Scale of Mental Tests	Eikeseth 2009[410]	–	'Visual spatial IQ'
	Magiati 2007[308]	–	Cognitive ability/mental age
	Sheinkopf 1998[429]	–	'Cognitive measure'
	Sheinkopf 2000[412]	–	'Cognitive developmental level . . . emphasis on nonverbal skills'
	Smith 2000[413]	–	'Intellectual functioning'
Merrill-Palmer-Revised	Smith 2010[359]	Receptive language subscale, cognition, fine motor	'Language/communication', 'cognitive ability'
Mullen Scales of Early Learning (MSEL)	Akshoomoff 2006[395]	Visual reception, fine motor, receptive language, expressive language	'Cognitive ability . . . separate scores for verbal and non-verbal skills'
	Anan 2008[396]	Visual reception, fine motor, receptive language, expressive language	Cognitive functioning
	Baker 2010[397]	Expressive language, receptive language	'Language ability'
	Barbaro 2012[398]	Visual perception, fine motor, receptive language, expressive language	Developmental status
	Ben Itzchak 2011[320]	Visual reception, fine motor, expressive language, language comprehension	Cognitive abilities
	Bishop 2011[176]	Non-verbal, verbal	Intellectual development (non-verbal and verbal IQ)
	Brian 2008[305]	Composite (visual reception, receptive, expressive, fine motor)	Cognitive ability

Cognitive ability	Paper	Subscales used	Outcome(s) measured according to the author
	Dawson 2010[321]	Fine motor, receptive language, expressive language, visual problem solving	'Fine motor, visual reception, expressive language, and receptive language'
	Dereu 2012[365]	Age equivalents	General development
	Eapen 2013[357]	–	Early development
	Hartley 2009[323]	Visual reception, fine motor, receptive language, expressive language	Cognitive development
	Honey 2008[307]	Receptive language, expressive language	'Children's abilities'
	Landa 2012[399]	Gross motor, fine motor, visual reception, receptive language, expressive language	'Development'
	Landa 2012[224]	–	IQ
	Lloyd 2013[400]	Gross motor, fine motor, visual reception, receptive language, expressive language	IQ, gross and fine motor skills
	Luyster 2008[129]	Receptive language, expressive language, visual reception, fine motor skill	Language ability
	Mayo 2013[310]	Gross motor, fine motor, visual reception, receptive language, expressive language	Cognitive development
	Mitchell 2006[392]	–	'Expressive and receptive language skills'
	O'Donnell 2012[386]	Visual reception, receptive language, expressive language, fine motor	'Cognitive functioning'
	Ozonoff 2010[313]	Fine motor, receptive language, expressive language, visual problem solving	'Cognitive functioning'
	Poon 2012[401]	–	'Intellectual abilities'
	Ray-Subramanian 2012[328]	Visual reception raw scores	Non-verbal cognition
	Rogers 2012[317]	Receptive language, expressive language, visual reception, fine motor skill	An overall index of ability
	Schertz 2013[402]	Receptive language, expressive language	Cognitive functioning
	Siller 2013[403]	Expressive language	Non-verbal cognitive and language abilities
	Sullivan 2007[330]	Gross motor, fine motor, visual reception, receptive language, expressive language	'Overall cognitive development'
	Tek 2012[331]	Visual reception, expressive language, receptive language, fine motor, gross motor	Comprehensive assessment of development
	Thurm 2007[404]	Receptive language organisation, expressive language organisation	'Language ability'

Cognitive ability	Paper	Subscales used	Outcome(s) measured according to the author
	Toth 2006[284]	Receptive language, expressive language	'Receptive and expressive language'
	Ventola 2007[332]	Fine motor, receptive language, expressive language, visual problem solving	'Ability'
	Werner 2005[316]	Composite IQ, verbal IQ	'Developmental outcomes'
	Zachor 2010[335]	Visual reception, fine motor, expressive language, receptive language	'Non-verbal cognitive measure . . . and verbal measure'
Snijders–Oomen Non-Verbal Intelligence Test (SON)	Peters-Scheffer 2010[421]	–	'Non-verbal intelligence'
	Ben Itzchak 2008[149]	–	Cognitive ability – verbal reasoning, quantitative reasoning, abstract/visual reasoning and short-term memory skills
Stanford–Binet Intelligence Scales	Delmolino 2006[432]	Verbal reasoning, abstract visual reasoning, quantitative reasoning, short term memory	Cognitive development, general development
	Grindle 2012[417]	–	IQ
	Harris 1991[408]	–	IQ
	Harris 2000[433]	–	IQ
	Landa 2012[224]	–	IQ
	Remington 2007[358]	–	'Intellectual functioning'
	Smith 2000[413]	–	'Intellectual functioning'
	Szatmari 2000[302]	Pattern analysis subtest	'Non-verbal problem-solving skills'
	Zachor 2006[334]	–	Cognitive ability – verbal reasoning, quantitative reasoning, abstract/visual reasoning and short-term memory skills
Wechsler Intelligence Scale for Children	Szatmari 2000	Block design subtest	'Visual-analytic skills'
Wechsler Preschool and Primary Scale of Intelligence (WPPSI)	Andersson 2013[409]	–	Intelligence (verbal and performance)
	Baghdadli 2012[339]	Block design	Psychological development, object-related cognition functioning: perceptual organisation and/or simultaneous information processing
	Baghdadli 2012[339]	Block design	Psychological development, object-related cognition functioning: perceptual organisation and/or simultaneous information processing
	Carlsson 2013[390]	–	Intellectual/cognitive function
	Eikeseth 2009[410]	–	'Intellectual functioning'

Cognitive ability	Paper	Subscales used	Outcome(s) measured according to the author
	Hedvall 2013[418]	Full-scale IQ, verbal IQ, performance IQ, processing speed quotient, general language composite	–
	Jonsdottir 2007[341]	–	Developmental progress
	Magiati 2007[308]	–	Cognitive ability and mental age
	Rickards 2009[423]	–	'Cognition'
	Sheinkopf 1998[429]	–	'Cognitive measure'
Differential Ability Scales[a]	Bishop 2011[176]	Non-verbal IQ, verbal IQ	–
	Ruble 2008[424]	–	'Cognitive functioning'
	Thurm 2007[404]	Verbal comprehension subtest, naming vocabulary subtest	'Receptive language'
Kyoto scale of psychological development[a]	Takeda 2005[360]	Posture–movement subtest, cognition–adaptation subtest, language–sociability subtest	'Development'
Tanaka–Binet intelligence test (Japanese version of Stanford–Binet)[a]	Takeda 2005[360]	–	'Intelligence'
Snabbt Performance Test På Intelligence IQ II (SPIQ) – Swedish[a]	Carlsson 2013[390]	–	Language – expressive and receptive

a Non-UK.

Attention	Paper	Subscales used	Outcome(s) measured according to the author
Behavior Assessment System for Children-Second Edition (BASC-2)	Hill-Chapman 2013[434]	–	Atypicality of symptoms
Child Behavior Scale (CBS)	Jahromi 2013[431]	Prosocial behaviours	Prosocial peer engagement
	Meek 2012[435]	Prosocial behaviours, asocial, exclusion, aggressive behaviours, hyperactive–distractible behaviours, anxious–fearful behaviours, social competence composite	'Social competence with peers'
Child Behavior Checklist (CBCL)	Baker 2010[397]	N/A	'Child behaviour problems'
	Hartley 2009[323]	–	Emotionally reactive, anxious/depressed, somatic complaints, sleep problems, attention problems, aggressive behaviour
	Peters-Scheffer 2010[421]	Behavioural problem scale	'Emotional and behavioural problems'
	Smith 2000[413]	Social withdrawal, somatisation, anxiety/depression, social problems, thought problems, attention problems, delinquency, aggression	'Socioeconomic functioning'
	Smith 2010[359]	Total problems, internalising problems, externalising problems, aggressive behavioural	'Behavioural problems'
	Taylor 2012[436]	Internalising problems, externalising problems, total problems composite	'Internalising and externalising behaviours in children'
Child Behaviour Questionnaire–Short Form	Jahromi 2013[431]	Inhibitory control, attentional focusing, low-intensity pleasure, perceptual sensitivity	Jahromi 2013[431]
Conners Rating Scales-Revised	Escalona 2001[271]	ADHD index, restless–impulsive behaviour, emotional index, the global index, inattentiveness	–
	Osborne 2009[351]	Oppositional behaviour, cognitive problems, hyperactivity, ADHD index	'Behavioural problems, hyperactivity and attention deficit disorder'
	Reed 2007[353]	Oppositional behaviour, cognitive problems, hyperactivity, ADHD index	'Behavioural difficulties'
	Reed 2013[437]	Oppositional behaviour, cognitive problems, hyperactivity, the ADHD index	Behavioural problems, hyperactivity and attention deficit disorder
Student attention – coded observation[a]	Travers 2011[438]	Attention to task, undesirable behaviour	'Student attention'

ADHD, attention deficit hyperactivity disorder; N/A, not available.
a Observational coding.

Emotion regulation	Paper	Subscales used	Outcome(s) measured according to the author
Baby and Infant Screen for Children with aUtIsm Traits (BISCUIT-Part 2)	Davis 2010[439]	Avoidance behaviour, anxiety/repetitive behaviour	Psychopathology comorbid with ASD
Behavior Assessment System for Children-Second Edition (BASC-2)	Hill-Chapman 2013[434]	–	Atypicality of symptoms
Child Behavior Checklist (CBCL)	Baker 2010[397]	N/A	'Child behaviour problems'
	Hartley 2009[323]	–	Emotionally reactive, anxious/depressed, somatic complaints, sleep problems, attention problems, aggressive behaviour
	Peters-Scheffer 2010[421]	Behavioural problem scale	'Emotional and behavioural problems'
	Smith 2000[413]	Social withdrawal, somatisation, anxiety/depression, social problems, thought problems, attention problems, delinquency, aggression	'Socioeconomic functioning'
	Smith 2010[359]	Total problems, internalising problems, externalising problems, aggressive behavioural	'Behavioural problems'
	Taylor 2012[436]	Internalising problems, externalising problems, total problems composite	'Internalising and externalising behaviours in children'
Children's Global Assessment Scale (CGAS)	Andersson 2013[409]	–	General social and psychiatric functioning
Conners Rating Scales-Revised	Escalona 2001[271]	ADHD index, restless–impulsive behaviour, emotional index, the global index, inattentiveness	–
	Osborne 2009[351]	Oppositional behaviour, cognitive problems, hyperactivity, ADHD index	'Behavioural problems, hyperactivity and attention deficit disorder'
	Reed 2007[353]	Oppositional behaviour, cognitive problems, hyperactivity, ADHD index	'Behavioural difficulties'
	Reed 2013[437]	Oppositional behaviour, cognitive problems, hyperactivity, the ADHD index	Behavioural problems, hyperactivity and attention deficit disorder
Developmental Behaviour Checklist	Herring 2006[411]	–	Child behavioural and emotional problems
	Mooney 2006[311]	–	'Repetitive behaviour'
	Remington 2007[358]	–	'Child behaviour'
	Roberts 2011[405]	–	'Adaptive functioning and psychopathology'
	Tonge 2012[425]	–	Severity of autism
Emotion Regulation Checklist	Jahromi 2013[431]	Negativity/lability, emotion regulation	Emotion regulation
Infant–Toddler Social–Emotional Assessment (ITSEA)	Ben-Sasson 2008[382]	Negative emotionality, depression/withdrawal, general anxiety, separation distress, inhibition to novelty	'Social–emotional and behavioural problems and competencies'

ADHD, attention deficit hyperactivity disorder; N/A, not available.

Physical skills	Paper	Subscales used	Outcome(s) measured according to the author
Annett's Pegs	Szatmari 2000[302]	–	'Motor dexterity'
Beery Visual–Motor Integration Test	Szatmari 2000[302]	–	'Visual-motor integration'
Brunet–Lezine's Oculomotor Coordination Subtest	Baghdadli 2012[339]	Oculomotor co-ordination subtest	Psychological development, object related cognition functioning, person related cognition functioning
Functional Independence Measure for Children (WeeFIM)	Jasmin 2009[384]	–	DLS
Infant Motor Maturity and Atypicality Coding Scales	Ozonoff 2008[440]	Walk, crawl, sit, roll, prone, supine abnormalities	'Motor maturity, protective responses, and movement abnormalities'
Mullen Scales of Early Learning (MSEL)	Akshoomoff 2006[395]	Visual reception, fine motor, receptive language, expressive language	'Cognitive ability . . . separate scores for verbal and non-verbal skills'
	Anan 2008[396]	Visual reception, fine motor, receptive language, expressive language	Cognitive functioning
	Baker 2010[397]	Expressive language, receptive language	'Language ability'
	Barbaro 2012[398]	Visual perception, fine motor, receptive language, expressive language	Developmental status
	Ben Itzchak 2011[320]	Visual reception, fine motor, expressive language, language comprehension	Cognitive abilities
	Bishop 2011[176]	Non-verbal, verbal	Intellectual development (non-verbal and verbal IQ)
	Brian 2008[305]	Composite (visual reception, receptive, expressive, fine motor)	Cognitive ability
	Dawson 2010[321]	Fine motor, receptive language, expressive language, visual problem solving	'Fine motor, visual reception, expressive language, and receptive language'
	Dereu 2012[365]	Age equivalents	General development
	Eapen 2013[357]	–	Early development
	Hartley 2009[323]	Visual reception, fine motor, receptive language, expressive language	Cognitive development
	Honey 2008[307]	Receptive language, expressive language	'Children's abilities'
	Landa 2012[399]	Gross motor, fine motor, visual reception, receptive language, expressive language	'Development'
	Landa 2012[224]	–	IQ
	Lloyd 2013[400]	Gross motor, fine motor, visual reception, receptive language, expressive language	IQ, gross and fine motor skills
	Luyster 2008[129]	Receptive language, expressive language, visual reception, fine motor skill	Language ability

Physical skills	Paper	Subscales used	Outcome(s) measured according to the author
	Mayo 2013[310]	Gross motor, fine motor, visual reception, receptive language, expressive language	Cognitive development
	Mitchell 2006[392]	–	'Expressive and receptive language skills'
	O'Donnell 2012[386]	Visual reception, receptive language, expressive language, fine motor	'Cognitive functioning'
	Ozonoff 2010[313]	Fine motor, receptive language, expressive language, visual problem-solving	'Cognitive functioning'
	Poon 2012[401]	–	'Intellectual abilities'
	Ray-Subramanian 2012[328]	Visual reception raw scores	Non-verbal cognition
	Rogers 2012[317]	Receptive language, expressive language, visual reception, fine motor skill	An overall index of ability
	Schertz 2013[402]	Receptive language, expressive language	Cognitive functioning
	Siller 2013[403]	Expressive language	Non-verbal cognitive and language abilities
	Sullivan 2007[330]	Gross motor, fine motor, visual reception, receptive language, expressive language	'Overall cognitive development'
	Tek 2012[331]	Visual reception, expressive language, receptive language, fine motor, gross motor	Comprehensive assessment of development
	Thurm 2007[404]	Receptive language organisation, expressive language organisation	'Language ability'
	Toth 2006[284]	Receptive language, expressive language	'Receptive and expressive language'
	Ventola 2007[332]	Fine motor, receptive language, expressive language, visual problem solving	'Ability'
	Werner 2005[316]	Composite IQ, verbal IQ	'Developmental outcomes'
	Zachor 2010[335]	Visual reception, fine motor, expressive language, receptive language	'Non-verbal cognitive measure . . . and verbal measure'
Peabody Developmental Motor Scales	Jasmin 2009[384]	–	Gross and fine motor skills
	Provost 2007[441]	Reflexes, stationary, locomotion, object manipulation, grasping, visual motor integration	'Gross motor and fine motor development'
Vineland Adaptive Behavior Scales-Classroom version (VABS-Classroom)	Goin-Kochel 2007[427]	Communication, DLS, socialisation, motor skills	Communication skills, DLS, socialisation skills, motor skills
Vineland Adaptive Behavior Scales (VABS)	Aldred 2004[318]	Communication, DLS, socialisation	'Communication, daily living skills, and socialisation'
	Anan 2008[396]	Communication, DLS, socialisation, motor skills	Adaptive functioning

Physical skills	Paper	Subscales used	Outcome(s) measured according to the author
	Andersson 2013[409]	–	Adaptive skills
	Arick 2003[388]	–	Adaptive behaviour
	Baghdadli 2012[339]	Communication, DLS, socialisation	Adaptive behaviours
	Bearss 2013[278]	–	Communication, DLS, socialisation, motor skills
	Ben Itzchak 2011[320]	Communication, DLS, socialisation, motor skills	Adaptive skills
	Bennett 2008[296]	Social, communication, DLS	Personal and social sufficiency
	Carlsson 2013[390]	Motor skills domain	Motor function
	Cassidy 2008[348]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Dawson 2010[321]	Communication, DLS, socialisation, motor skills	'Social, communication, motor, and daily living skills'
	Eapen 2013[357]	–	Communication – expressive and receptive, DLS, socialisation, motor skills
	Eikeseth 2009[410]	–	'Adaptive behaviours'
	Eldevik 2012[414]	Adaptive behaviour composite, communication, daily living, socialisation	Adaptive behaviour
	Eriksson 2013[415]	–	Adaptive skills
	Gabriels 2007[416]	Communication, DLS, socialisation, motor skills, adaptive behaviour composite	Adaptive behaviour skills
	Green 2010[253]	–	'Adaptive functioning in school beyond the family'
	Grindle 2012[417]	–	Adaptive skills, socialisation, communication, DLS, motor skills
	Hedvall 2013[418]	Communication, DLS, socialisation, motor skills	–
	Herring 2006[411]	Derived Adaptive Behaviour Composite (ABC) standard score	Adaptive behaviour
	Honey 2008[307]	Communication, socialisation	'Children's abilities'
	Hudry 2010[233]	Receptive language, expressive language	'Receptive and expressive language skills'
	Jasmin 2009[384]	DLS	DLS
	Jonsdottir 2007[341]	Composite	Adaptive behaviour in communication, DLS, socialisation and motor skills
	Klintwall 2012[419]	–	'Treatment gains . . . treatment outcomes'
	Landa 2012[224]	Communication domain standard score	Communication skills
	Lerna 2012[325]	–	Child communication, social abilities

Physical skills	Paper	Subscales used	Outcome(s) measured according to the author
	Lloyd 2013[400]	Communication, DLS, socialisation, motor skills	Communication, DLS, social skills, motor development
	Luyster 2008[129]	Motor, communication	Children's personal and social sufficiency in communication (receptive, expressive, written), DLS (personal, domestic, community), socialisation (interpersonal relationships, play and leisure, time, coping skills) and motor skills (gross, fine)
	Magiati 2007[308]	Communication, DLS, socialisation	Adaptive behaviour
	Magiati 2011[309]	Communication, DLS, socialisation, composite	Adaptive behaviour
	Mayo 2013[310]	Communication, DLS, socialisation, motor skills	Adaptive functioning
	McConkey 2010[349]	Communication, DLS, socialisation, motor skills	Communication, DLS, socialisation and motor skills
	Munson 2006[420]	Socialisation, communication	'Socialisation and communication skills'
	Munson 2008[312]	Social, communication, DLS, motor skills	'Adaptive behaviours'
	O'Donnell 2012[386]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Osborne 2008[350]	Communication, DLS, socialisation, motor skills	'Day-to-day adaptive functioning'
	Osborne 2009[351]	Communication, DLS, socialisation, motor skills	'Adaptive behavioural functioning'
	Peters-Scheffer 2010[421]	Communication, DLS, socialisation	'Adaptive behaviour'
	Poon 2012[401]	Communication	'Communication'
	Pry 2005[314]	Communication, DLS, socialisation	'Child's knowledge about the social norms, conventions, and scripts that govern social life at all levels'
	Ray-Subramanian 2011[327]	Communication, DLS, socialisation, motor skills	'Adaptive skills'
	Reed 2007[352]	Communication, DLS, socialisation, motor skills	'Adaptive functioning'
	Reed 2007[353]	Communication, DLS, socialisation, motor skills	'Adaptive functioning'
	Reed 2012[354]	Communication, DLS, socialisation, motor skills	Day-to-day adaptive behaviour
	Remington 2007[358]	Socialisation, communication, DLS, motor skills	'Adaptive skills'
	Restall 1994[422]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Rickards 2009[423]	–	'Communication, daily living skills, socialisation and motor skills'

Physical skills	Paper	Subscales used	Outcome(s) measured according to the author
	Roberts 2011[405]	–	'Communication and social skills'
	Rogers 2012[317]	Communication, DLS, socialisation, motor skills	Adaptive behaviour
	Ruble 2008[424]	Socialisation, communication	'Adaptive functioning'
	Salt 2002[372]	Communication, DLS, socialisation, motor skills	'Communication, daily living skills, socialisation and motor skills'
	Schertz 2013[402]	Communication	Adaptive behaviour
	Silva 2007[299]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Silva 2008[300]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Smith 2000[413]	Communication, DLS, socialisation	'Adaptive functioning'
	Smith 2010[359]	Communication, DLS, socialisation, motor skills	'Language/communication', 'adaptive behaviour'
	Stahmer 2004[355]	Communication, DLS, socialisation, motor skills	Child adaptive functioning
	Stone 1999[346]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Strauss 2012[329]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour functioning'
	Szatmari 2000[302]	Socialisation, communication	'Social skills' and 'language'
	Tonge 2012[425]	–	Adaptive behaviour
	Toth 2006[284]	Communication	'Communication skills'
	VanMeter 1997[426]	Communication, DLS, socialisation	'Social, communication, and daily living skills'
	Ventola 2007[332]	Socialisation, communication, DLS, motor skills	'Adaptive functioning'
	Werner 2005[316]	Communication, DLS, socialisation, motor skills	'Developmental outcomes'
	Zachor 2010[335]	Communication, DLS, socialisation, motor skills	'Adaptive functioning'

DLS, daily living skills.

Social communication	Paper	Subscales used	Outcome(s) measured according to the author
Autism Diagnostic Interview (ADI)	Ben Itzchak2008[149]	–	Autism severity
Autism Diagnostic Interview-Revised (ADI-R)	Bennett 2012[304]	Non verbal items were used so that results could be compared between verbal and non-verbal children	–
	Brian 2008[305]	–	–
	Feldman 2012[104]	–	–
	Hambly 2012[306]	Items on language (#42, 46, 29, 30, 9, 10)	Sociocommunicative levels, ages of early language milestones
	Honey 2008[307]	Repetitive behaviour algorithm items	'Repetitive behaviour'
	Magiati 2007[308]	–	Autism severity and diagnosis confirmation
	Magiati 2011[309]	Total score	Autism severity
	Mayo 2013[310]	–	Communication, social development and play, and the presence of repetitive or restricted behaviours
	Mooney 2006[311]	–	'Repetitive behaviours'
	Munson 2008[312]	Social relatedness, communication, repetitive, restricted behaviours	'Autism severity'
	Ozonoff 2010[313]	–	'Parent recall of symptom onset and possible regression'
	Pry 2005[314]	–	'Expressive language level'
	Richler 2007[315]	RRB items	'Restricted and repetitive behaviours'
	Werner 2005[316]	Social, communication, repetitive	'Developmental outcomes'
Autism Diagnostic Observation Scale-Toddler Module (ADOS-T)	Rogers 2012[317]	Social affect, restricted, repetitive behaviours	'Social and communicative behaviours, as well as repetitive behaviours diagnostic of autism'
	Aldred 2004[318]	Reciprocal social interaction, communication, stereotyped and restricted behaviours	'Interaction, communication, repetitive behaviours and play'
	Aldred 2012[319]	Total social communication algorithm score	Social communication
	Ben Itzchak 2008[149]	Language and communication, reciprocal social interaction, play, and stereotyped behaviour and restricted interests	Social and communicative functioning
	Ben Itzchak 2011[320]	ADOS standardised measure of severity	Autism severity, diagnostic algorithm

Social communication	Paper	Subscales used	Outcome(s) measured according to the author
Autism Diagnostic Observation Schedule (ADOS)	Bennett 2012[304]	–	Social and communication behaviours
	Brian 2008[305]	Module 1	–
	Dawson 2010[321]	Social relatedness, communication, play, repetitive behaviours	'Autism symptoms'
	Gotham 2012[322]	–	Symptom severity
	Green 2010[253]	Communication, social	'Severity of the symptoms of autism'
	Hartley 2009[323]	Communication, social interaction, restricted behaviours	ASD symptoms
	Landa 2012[224]	–	Symptom severity
	Lerna 2012[325]	Communication, reciprocal social interaction	Social communicative abilities
	Luyster 2008[129]	Play	–
	Munson 2008[312]	Communication, social	'Autism severity'
	Oosterling 2010[326]	Level of non-echoed language, joint attention, social affect	Language development, early precursors of social communication
	Ray-Subramanian 2011[327]	–	'Social communication skills and behaviours characteristic of autism'
	Ray-Subramanian 2012[328]	Calibrated ADOS severity scores, composite RRB variable	RRB
	Strauss 2012[329]	Communication, social	'Severity of autism symptoms'
	Sullivan 2007[330]	Response to joint attention item	'Response to joint attention'
	Tek 2012[331]	Communication, reciprocal social interaction	Assessment for ASD
	Ventola 2007[332]	Communication, social	'Communication, social interactions and relatedness, play, and imagination'
	Werner 2005[316]	Communication, social	'Developmental outcomes'
	Wong 2010[333]	Language and communication, reciprocal social interaction	'Assessing autism spectrum disorder'
	Zachor 2006[334]	Language and communication, reciprocal social interaction	Language and communication and reciprocal social interaction
	Zachor 2010[335]	–	'Autism severity'
Autism Screening Instrument for Educational Planning (ASIEP)	Arick 2003[388]	Autism Behavior Checklist, Sample of Vocal Behaviour, Social Interaction Assessment, Educational Assessment	Educational progress
Communication and Symbolic Behavior Scales-Developmental Profile (Caregiver Questionnaire) (CSBS-DP-CQ); Wetherby and Prizant 2002[125])	Tek 2012[331]	CSBS-DP-CQ Words, CSBS-DP-CQ Understanding Words, CSBS-DP-CQ Social Composite	Language and social development

Social communication	Paper	Subscales used	Outcome(s) measured according to the author
Early Social Communication Scale (ESCS)	Dereu 2012[365]	–	Initiating joint attention, responding to joint attention
	Goods 2013[366]	Spontaneous requesting gestures	Spontaneous requesting gestures
	Ingersoll 2012[286]	–	Social interaction
	Kaale 2012[294]	–	Joint attention
	Kalas 2012[367]	–	Responses to bids for joint attention
	Kasari 2006[368]	–	Social communication
	Lawton 2012[369]	–	Joint attention, social interaction, symbolic play and behaviour regulation
	Luyster 2008[129]	Initiating joint attention, responding to joint attention	–
	Paparella 2011[370]	–	'Initiations and responses of Joint Attention behaviours'
	Remington 2007[358]	Initiating joint attention, responding to joint attention	'Non-verbal social communication'
	Roos 2008[371]	Initiating joint attention, responding to joint attention	'Joint attention'
	Wong 2013[373]	–	Non-verbal initiations and responses to joint attention, behaviour regulation or requesting behaviours, and social interactions
	Yoder 2006[374]	Communication	–
		Joint attention, requesting, social interaction	'Non-verbal social communication'
Early Social Communication Scales (ESCS)-Abridged	Yoder 2010[375]	–	'Number of picture exchanges at post treatment assessment'
Pragmatics Profile	Roberts 2011[405]	–	'Communication'
Social Communication Assessment for Toddlers with Autism (SCATA)	Drew 2007[137]	–	Social communication (contexts: free play, turn-taking, activated musical toys, bubbles, specific prompts)
Social Communication Behavior Codes	Ozonoff 2010[313]	Gaze to faces, gaze to objects, smiles, non-verbal vocalisations, single word verbalisations, phrase verbalisations	'Social communication behaviour'
Vineland Adaptive Behavior Scales-Classroom version (VABS-Classroom)	Goin-Kochel 2007[427]	Communication, DLS, socialisation, motor skills	Communication skills, DLS, socialisation skills, motor skills
Vineland Adaptive Behavior Scales (VABS)	Aldred 2004[318]	Communication, DLS, socialisation	'Communication, daily living skills, and socialisation'
	Anan 2008[396]	Communication, DLS, socialisation, motor skills	Adaptive functioning
	Andersson 2013[409]	–	Adaptive skills
	Arick 2003[388]	–	Adaptive behaviour

Social communication	Paper	Subscales used	Outcome(s) measured according to the author
	Baghdadli 2012[339]	Communication, DLS, socialisation	Adaptive behaviours
	Bearss 2013[278]	–	Communication, DLS, socialisation, motor skills
	Bennett 2008[296]	Social, communication, DLS	Personal and social sufficiency
	Carlsson 2013[390]	Motor skills domain	Motor function
	Cassidy 2008[348]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Dawson 2010[321]	Communication, DLS, socialisation, motor skills	'Social, communication, motor, and daily living skills'
	Eikeseth 2009[410]	–	'Adaptive behaviours'
	Eldevik 2012[414]	Adaptive behaviour composite, communication, DLS, socialisation	Adaptive behaviour
	Eriksson 2013[415]	–	Adaptive skills
	Gabriels 2007[416]	Communication, DLS, socialisation, motor skills, adaptive behaviour composite	Adaptive behaviour skills
	Green 2010[253]	–	'Adaptive functioning in school beyond the family'
	Grindle 2012[417]	–	Adaptive skills, socialisation, communication, DLS, motor skills
	Hedvall 2013[418]	Communication, DLS, socialisation, motor skills	–
	Herring 2006[411]	Derived Adaptive Behaviour Composite (ABC) standard score	Adaptive behaviour
	Honey 2008[307]	Communication, socialisation	'Children's abilities'
	Hudry 2010[233]	Receptive language, expressive language	'Receptive and expressive language skills'
	Ben Itzchak 2011[320]	Communication, DLS, socialisation, motor skills	Adaptive skills
	Jasmin 2009[384]	DLS	DLS
	Jonsdottir 2007[341]	Composite	Adaptive behaviour in communication, DLS, socialisation, and motor skills
	Klintwall 2012[419]	–	'Treatment gains . . . treatment outcomes'
	Landa 2012[224]	Communication domain standard score	Communication skills
	Lerna 2012[325]	–	Child communication, social abilities
	Lloyd 2013[400]	Communication, DLS, socialisation, motor skills	Communication, DLS, social skills, motor development

Social communication	Paper	Subscales used	Outcome(s) measured according to the author
	Luyster 2008[129]	Motor, communication	Children's personal and social sufficiency in communication (receptive, expressive, written), DLS (personal, domestic, community), socialisation (interpersonal relationships, play and leisure, time, coping skills) and motor skills (gross, fine)
	Magiati 2007[308]	Communication, DLS, socialisation	Adaptive behaviour
	Magiati 2011[309]	Communication, DLS, socialisation, composite	Adaptive behaviour
	Mayo 2013[310]	Communication, DLS, socialisation, motor skills	Adaptive functioning
	McConkey 2010[349]	Communication, DLS, socialisation, motor skills	Communication, DLS, socialisation and motor skills
	Munson 2006[420]	Socialisation, communication	'Socialisation and communication skills'
	Munson 2008[312]	Social, communication, DLS, motor skills	'Adaptive behaviours'
	O'Donnell 2012[386]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Eapen 2013[357]	–	Communication – expressive and receptive, DLS, socialisation, motor skills
	Osborne 2008[350]	Communication, DLS, socialisation, motor skills	'Day-to-day adaptive functioning'
	Osborne 2009[351]	Communication, DLS, socialisation, motor skills	'Adaptive behavioural functioning'
	Peters-Scheffer 2010[421]	Communication, DLS, socialisation	'Adaptive behaviour'
	Poon 2012[401]	Communication	'Communication'
	Pry 2005[314]	Communication, DLS, socialisation	'Child's knowledge about the social norms, conventions, and scripts that govern social life at all levels'
	Ray-Subramanian 2011[327]	Communication, DLS, socialisation, motor skills	'Adaptive skills'
	Reed 2007[352]	Communication, DLS, socialisation, motor skills	'Adaptive functioning'
	Reed 2007[353]	Communication, DLS, socialisation, motor skills	'Adaptive functioning'
	Reed 2012[354]	Communication, DLS, socialisation, motor skills	Day-to-day adaptive behaviour
	Remington 2007[358]	Socialisation, communication, DLS, motor skills	'Adaptive skills'
	Restall 1994[422]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'

Social communication	Paper	Subscales used	Outcome(s) measured according to the author
	Rickards 2009[423]	–	'Communication, daily living skills, socialisation and motor skills'
	Roberts 2011[405]	–	'Communication and social skills'
	Rogers 2012[317]	Communication, DLS, socialisation, motor skills	Adaptive behaviour
	Ruble 2008[424]	Socialisation, communication	'Adaptive functioning'
	Salt 2002[372]	Communication, DLS, socialisation, motor skills	'Communication, daily living skills, socialisation and motor skills'
	Schertz 2013[402]	Communication	Adaptive behaviour
	Silva 2007[299]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Silva 2008[300]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Smith 2000[413]	Communication, DLS, socialisation	'Adaptive functioning'
	Smith 2010[359]	Communication, DLS, socialisation, motor skills	'Language/communication', 'adaptive behaviour'
	Stahmer 2004[355]	Communication, DLS, socialisation, motor skills	Child adaptive functioning
	Stone 1999[346]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Strauss 2012[329]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour functioning'
Vineland Adaptive Behavior Scales (VABS)	Szatmari 2000[302]	Socialisation, communication	'Social skills' and 'language'
	Tonge 2012[425]	–	Adaptive behaviour
	Toth 2006[284]	Communication	'Communication skills'
	VanMeter 1997[426]	Communication, DLS, socialisation	'Social, communication, and daily living skills'
	Ventola 2007[332]	Socialisation, communication, DLS, motor skills	'Adaptive functioning'
	Werner 2005[316]	Communication, DLS, socialisation, motor skills	'Developmental outcomes'
	Zachor 2010[335]	Communication, DLS, socialisation, motor skills	'Adaptive functioning'
Parent Survey[a]	Arick 2003[388]	–	Communication, social interaction, behaviour, parents' satisfaction

Social communication	Paper	Subscales used	Outcome(s) measured according to the author
Caregiver–child interaction[b]	Kasari 2006[368]	–	Functional play acts, play levels, joint attention skills, joint engagement
Classroom and playground behaviour observations[b]	Escalona 2001[271]	–	Positive response to touch, on-task behaviour, stereotypical behaviour, social relatedness to the teacher
Coding of initiation of joint attention[b]	Ingersoll 2012[286]	–	Initiation of joint attention
Examiner Ratings of Social Engagement[b]	Ozonoff 2010[313]	Frequency of eye contact, frequency of shared affect, overall social responsiveness	'Social engagement'
Parent–child interaction[b]	Green 2010[253]	Parent synchrony, child initiations, mutual shared attention	Parent–child interaction during naturalistic play
Parent–Child Interaction measure[b]	Aldred 2012[319]	–	Aldred 2012[319]
Preschool teacher–child play[b]	Kaale 2012[294]	–	Joint attention and joint engagement
Unstructured free play with examiner[b]	Lerna 2012[325]	–	Co-operative play, joint attention, requests labelling
Video coding procedures[b]	Colgan 2006[379]	–	Communicative gestures
Video recording of child in classroom activities[b]	Ingersoll 2001[380]	Language, peer social avoidance	Peer social avoidance behaviour, language

DLS, daily living skills.
a Tools developed ad hoc.
b Observational coding.

Social functioning	Paper	Subscales used	Outcome(s) measured according to the author
Autism Diagnostic Interview (ADI)	Ben Itzchak 2008[149]	–	Autism severity
Autism Diagnostic Interview-Revised (ADI-R)	Bennett 2012[304]	Non-verbal items were used so that results could be compared between verbal and non-verbal children	–
	Brian 2008[305]	–	–
	Feldman 2012[104]	–	–
	Hambly 2012[306]	Items on language (#42, 46, 29, 30, 9, 10)	Sociocommunicative levels, ages of early language milestones
Autism Diagnostic Interview (ADI)	Honey 2008[307]	Repetitive behaviour algorithm items	'Repetitive behaviour'
Autism Diagnostic Interview-Revised (ADI-R)	Magiati 2007[308]	–	Autism severity and diagnosis confirmation
	Magiati 2011[309]	Total score	Autism severity
	Mayo 2013[310]	–	Communication, social development and play, and the presence of repetitive or restricted behaviours
	Mooney 2006[311]	–	'Repetitive behaviours'
	Munson 2008[312]	Social relatedness, communication, repetitive, restricted behaviours	'Autism severity'
	Ozonoff 2010[313]	–	'Parent recall of symptom onset and possible regression'
Autism Diagnostic Interview (ADI)	Pry 2005[314]	–	'Expressive language level'
Autism Diagnostic Interview-Revised (ADI-R)	Richler 2007[315]	RRB	'Restricted and repetitive behaviours'
Autism Diagnostic Interview (ADI)	Werner 2005[316]	Social, communication, repetitive	'Developmental outcomes'
Child Behavior Scale (CBS)	Jahromi 2013[431]	Prosocial behaviours	Prosocial peer engagement
	Meek 2012[435]	Prosocial behaviours, asocial, exclusion, aggressive behaviours, hyperactive–distractible behaviours, anxious–fearful behaviours, social competence composite	'Social competence with peers'
Nisonger Child Behavior Rating Scales	Remington 2007[358]	Positive Social Subscale	'Child behaviour'
Social Behavior Rating Scale	Vorgraft 2007[347]	–	'Children's social interactive behaviour'
Vineland Adaptive Behavior Scales-Classroom version (VABS-Classroom)	Goin-Kochel 2007[427]	Communication, DLS, socialisation, motor skills	Communication skills, DLS, socialisation skills, motor skills

Social functioning	Paper	Subscales used	Outcome(s) measured according to the author
Vineland Adaptive Behavior Scales (VABS)	Aldred 2004[318]	Communication, DLS, socialisation	'Communication, daily living skills, and socialisation'
	Anan 2008[396]	Communication, DLS, socialisation, motor skills	Adaptive functioning
	Andersson 2013[409]	–	Adaptive skills
	Arick 2003[388]	–	Adaptive behaviour
	Baghdadli 2012[339]	Communication, DLS, socialisation	Adaptive behaviours
	Bearss 2013[278]	–	Communication, DLS, socialisation, motor skills
	Bennett 2008[296]	Social, communication, DLS	Personal and social sufficiency
	Carlsson 2013[390]	Motor Skills domain	Motor function
	Cassidy 2008[348]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Dawson 2010[321]	Communication, DLS, socialisation, motor skills	'Social, communication, motor, and daily living skills'
	Eikeseth 2009[410]	–	'Adaptive behaviours'
	Eldevik 2012[414]	Adaptive behaviour composite, communication, daily living, socialisation	Adaptive behaviour
	Eriksson 2013[415]	–	Adaptive skills
	Gabriels 2007[416]	Communication, DLS, socialisation, motor skills, adaptive behaviour composite	Adaptive behaviour skills
	Green 2010[253]	–	'Adaptive functioning in school beyond the family'
	Grindle 2012[417]	–	Adaptive skills, socialisation, communication, DLS, motor skills
	Hedvall 2013[418]	Communication, DLS, socialisation, motor skills	–
	Herring 2006[411]	Derived Adaptive Behaviour Composite (ABC) standard score	Adaptive behaviour
	Honey 2008[307]	Communication, socialisation	'Children's abilities'
	Hudry 2010[233]	Receptive language, expressive language	'Receptive and expressive language skills'
	Ben Itzchak 2011[320]	Communication, DLS, socialisation, motor skills	Adaptive skills
	Jasmin 2009[384]	DLS	DLS
	Jonsdottir 2007[341]	Composite	Adaptive behaviour in communication, DLS, socialisation and motor skills
	Klintwall 2012[427]	–	'Treatment gains . . . treatment outcomes'

Social functioning	Paper	Subscales used	Outcome(s) measured according to the author
	Landa 2012[224]	Communication domain standard score	Communication skills
	Lerna 2012[325]	–	Child communication, social abilities
	Lloyd 2013[400]	Communication, DLS, socialisation, motor skills	Communication, DLS, social skills, motor development
	Luyster 2008[129]	Motor, communication	Children's personal and social sufficiency in communication (receptive, expressive, written), DLS (personal, domestic, community), socialisation (interpersonal relationships, play and leisure, time, coping skills) and motor skills (gross, fine)
	Magiati 2007[308]	Communication, DLS, socialisation	Adaptive behaviour
	Magiati 2011[309]	Communication, DLS, socialisation, composite	Adaptive behaviour
	Mayo 2013[310]	Communication, DLS, socialisation, motor skills	Adaptive functioning
	McConkey 2010[349]	Communication, DLS, socialisation, motor skills	Communication, DLS, socialisation and motor skills
	Munson 2006[420]	Socialisation, communication	'Socialisation and communication skills'
	Munson 2008[312]	Social, communication, DLS, motor skills	'Adaptive behaviours'
	O'Donnell 2012[386]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Eapen 2013[357]	–	Communication – expressive and receptive, DLS, socialisation, motor skills
	Osborne 2008[350]	Communication, DLS, socialisation, motor skills	'Day-to-day adaptive functioning'
	Osborne 2009[351]	Communication, DLS, socialisation, motor skills	'Adaptive behavioural functioning'
	Peters-Scheffer 2010[421]	Communication, DLS, socialisation	'Adaptive behaviour'
	Poon 2012[401]	Communication	'Communication'
	Pry 2005[314]	Communication, DLS, socialisation	'Child's knowledge about the social norms, conventions, and scripts that govern social life at all levels'
	Ray-Subramanian 2011[327]	Communication, DLS, socialisation, motor skills	'Adaptive skills'
	Reed 2007[352]	Communication, DLS, socialisation, motor skills	'Adaptive functioning'
	Reed 2007[353]	Communication, DLS, socialisation, motor skills	'Adaptive functioning'
	Reed 2012[354]	Communication, DLS, socialisation, motor skills	Day-to-day adaptive behaviour

Social functioning	Paper	Subscales used	Outcome(s) measured according to the author
	Remington 2007[358]	Socialisation, communication, DLS, motor skills	'Adaptive skills'
	Restall 1994[422]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Rickards 2009[423]	–	'Communication, daily living skills, socialisation and motor skills'
	Roberts 2011[405]	–	'Communication and social skills'
	Rogers 2012[317]	Communication, DLS, socialisation, motor skills	Adaptive behaviour
	Ruble 2008[424]	Socialisation, communication	'Adaptive functioning'
	Salt 2002[372]	Communication, DLS, socialisation, motor skills	'Communication, daily living skills, socialisation and motor skills'
	Schertz 2013[402]	Communication	Adaptive behaviour
	Silva 2007[299]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Silva 2008[300]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Smith 2000[413]	Communication, DLS, socialisation	'Adaptive functioning'
	Smith 2010[359]	Communication, DLS, socialisation, motor skills	'Language/communication', 'adaptive behaviour'
	Stahmer 2004[355]	Communication, DLS, socialisation, motor skills	Child adaptive functioning
	Stone 1999[346]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Strauss 2012[329]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour functioning'
	Szatmari 2000[302]	Socialisation, communication	'Social skills' and 'language'
	Tonge 2012[425]	–	Adaptive behaviour
	Toth 2006[284]	Communication	'Communication skills'
	VanMeter 1997[426]	Communication, DLS, socialisation	'Social, communication, and daily living skills'
	Ventola 2007[332]	Socialisation, communication, DLS, motor skills	'Adaptive functioning'
	Werner 2005[316]	Communication, DLS, socialisation, motor skills	'Developmental outcomes'
	Zachor 2010[335]	Communication, DLS, socialisation, motor skills	'Adaptive functioning'
Vineland Social Maturity Scale, Indian adaptation[a]	Malhi 2011[342]	–	Adaptive behaviour
Parent Survey[b]	Arick 2003[388]	–	Communication, social interaction, behaviour, parents' satisfaction

Social functioning	Paper	Subscales used	Outcome(s) measured according to the author
Classroom and playground behaviour observations[c]	Escalona 2001[271]	–	Positive response to touch, on-task behaviour, stereotypical behaviour, social relatedness to the teacher
Coded observation of social behaviour[c]	Meirsschaut 2011[442]	Child's level of play, mother's play-stimulation, child's social initiatives, child responses, mother's social initiatives, mother's responses	'Social behaviour'
Video recording of child in classroom activities[c]	Ingersoll 2001[380]	Language, peer social avoidance	Peer social avoidance behaviour, language

DLS, daily living skills.
a Non-UK.
b Tools developed ad hoc.
c Observational coding.

Play	Paper	Subscales used	Outcome(s) measured according to the author
Autism Diagnostic Observation Scale-Toddler Module (ADOS-T)	Rogers 2012[317]	Social affect, restricted, repetitive behaviours	'Social and communicative behaviours, as well as repetitive behaviours diagnostic of autism'
Autism Diagnostic Observation Schedule (ADOS)	Aldred 2004[318]	Reciprocal social interaction, communication, stereotyped and restricted behaviours	'Interaction, communication, repetitive behaviours and play'
	Aldred 2012[319]	Total social communication algorithm score	Social communication
	Ben Itzchak 2008[149]	Language and communication, reciprocal social interaction, play, and stereotyped behaviour and restricted interests	Social and communicative functioning
	Ben Itzchak 2011[320]	ADOS standardised measure of severity	Autism severity, diagnostic algorithm
	Bennett 2012[304]	–	Social and communication behaviours
	Brian 2008[305]	Module 1	–
	Dawson 2010[321]	Social relatedness, communication, play, repetitive behaviours	'Autism symptoms'
	Gotham 2012[322]	–	Symptom severity
Autism Diagnostic Observation Schedule-Generic (ADOS-G)	Green 2010[253]	Communication, social	'Severity of the symptoms of autism'
	Hartley 2009[323]	Communication, social interaction, restricted behaviours	ASD symptoms
Autism Diagnostic Observation Schedule (ADOS)	Landa 2012[224]	–	Symptom severity
	Lerna 2012[325]	Communication, reciprocal social interaction	Social communicative abilities
	Luyster 2008[129]	Play	–
Autism Diagnostic Observation Schedule-Generic (ADOS-G)	Munson 2008[312]	Communication, social	'Autism severity'
Autism Diagnostic Observation Schedule (ADOS)	Oosterling 2010[326]	Level of non-echoed language, joint attention, social affect	Language development, EARLY precursors of social communication
	Ray-Subramanian 2011[327]	–	'Social communication skills and behaviours characteristic of autism'
	Ray-Subramanian 2012[328]	Calibrated ADOS severity scores, composite RRB variable	RRB
	Strauss 2012[329]	Communication, social	'Severity of autism symptoms'
	Sullivan 2007[330]	Response to joint attention item	'Response to joint attention'
Autism Diagnostic Observation Schedule-Generic (ADOS-G)	Tek 2012[331]	Communication, reciprocal social interaction	Assessment for ASD
	Ventola 2007[332]	Communication, social	'Communication, social interactions and relatedness, play, and imagination'

Play	Paper	Subscales used	Outcome(s) measured according to the author
Autism Diagnostic Observation Schedule (ADOS)	Werner 2005[316]	Communication, social	'Developmental outcomes'
	Wong 2010[333]	Language and communication, reciprocal social interaction	'Assessing autism spectrum disorder'
	Zachor 2006[334]	Language and communication, reciprocal social interaction	Language and communication and reciprocal social interaction
	Zachor 2010[335]	–	'Autism severity'
Communication and Symbolic Behavior Scales-Developmental Profile (Caregiver Questionnaire) (CSBS-DP-CQ); Wetherby and Prizant 2002[125])	Tek 2012[331]	CSBS-DP-CQ Words, CSBS-DP-CQ Understanding Words, CSBS-DP-CQ Social Composite	Language and social development
Developmental Play Assessment (DPA) - Instrument Sequence of Categories	Freeman 2013[443]	Play acts, play schemes, level of play	–
	Freeman 2013[443]	–	Level of play, type of play behaviour, frequency of play behaviours
	Goods 2013[366]	–	Play
	Kasari 2006[368]	–	Functional play (the number of different novel, child initiated, functional play acts), symbolic play types, play level
Symbolic Play Test	Wong 2010[333]	–	'Language potential of preverbal children'
	Salt 2002[372]	–	'Functional play'
	Magiati 2007[308]	–	Symbolic play
Test of Pretend Play (ToPP)	Magiati 2007[308]	–	Symbolic play
	Dereu 2012[365]	–	Functional and symbolic play development
Preschool Play Scale[a]	Restall 1994[422]	Space management, material management, imitation, participation	'Play performance'
Caregiver–child interaction[b]	Kasari 2006[368]	–	Functional play acts, play levels, joint attention skills, joint engagement
Coded observation of social behaviour[b]	Meirsschaut 2011[442]	Child's level of play, mother's play stimulation, child's social initiatives, child responses, mother's social initiatives, mother's responses	'Social behaviour'
Coding of videos[b]	Flippin 2011[406]	Parent play responsiveness, parent verbal responsiveness, child object play (exploratory, relational, functional, symbolic)	Object play skills, parent responsiveness
Free play assessment[b]	Christensen 2010[444]	Total functional play, object directed functional play, self-directed functional play, other directed functional play, symbolic play, functional repeated play, non-functional repeated play, total play acts	'Play behaviours'
Parent–child free play[b]	Freeman 2013[443]	–	Play acts, play schemes

a Pre-1995.
b Observational coding.

Behaviour	Paper	Subscales used	Outcome(s) measured according to the author
Aberrant Behavior Checklist (ABC)	Baghdadli 2012[339]	–	Self-injurious behaviours (SIB)
	Bearss 2013[278]	Irritability (tantrums, aggression and self-injury), social withdrawal, stereotypes, hyperactivity, inappropriate speech	Irritability, social withdrawal, stereotypes, hyperactivity, inappropriate speech
	O'Donnell 2012[386]	Irritability, agitation, crying, lethargy, social withdrawal, stereotypic behaviour, hyperactivity, non-compliance, inappropriate speech	'Challenging behaviours'
	Werner 2005[316]	Lethargy/withdrawal, stereotypic behaviour, hyperactivity, compliance, inappropriate speech	'Developmental outcomes'
Baby and Infant Screen for Children with aUtIsm Traits (BISCUIT-Part 3)	Rojahn 2009[445]	–	'Challenging behaviours in toddlers'
Behavior Assessment System for Children-Second Edition (BASC-2)	Hill-Chapman 2013[434]	–	Atypicality of symptoms
Behavior Screening Questionnaire	Rickards 2009[423]	–	'Behaviour'
Child Behavior Checklist (CBCL)	Baker 2010[397]	N/A	'Child behaviour problems'
	Hartley 2009[323]	–	Emotionally reactive, anxious/depressed, somatic complaints, sleep problems, attention problems, aggressive behaviour
	Peters-Scheffer 2010[421]	Behavioural problem scale	'Emotional and behavioural problems'
	Smith 2000[413]	Social withdrawal, somatisation, anxiety/depression, social problems, thought problems, attention problems, delinquency, aggression	'Socioeconomic functioning'
	Smith 2010[359]	Total problems, internalising problems, externalising problems, aggressive behavioural	'Behavioural problems'
	Taylor 2012[436]	Internalising problems, externalising problems, total problems composite	'Internalising and externalising behaviours in children'
Child Behavior Scale (CBS)	Jahromi 2013[431]	Prosocial behaviours	Prosocial peer engagement
	Meek 2012[435]	Prosocial behaviours, asocial, exclusion, aggressive behaviours, hyperactive–distractible behaviours, anxious–fearful behaviours, social competence composite	'Social competence with peers'

Behaviour	Paper	Subscales used	Outcome(s) measured according to the author
Conners Rating Scales-Revised	Escalona 2001[271]	ADHD Index, restless–impulsive behaviour, emotional index, the global index, inattentiveness	–
	Osborne 2009[351]	Oppositional behaviour, cognitive problems, hyperactivity, ADHD index	'Behavioural problems, hyperactivity and attention deficit disorder'
	Reed 2007[353]	Oppositional behaviour, cognitive problems, hyperactivity, ADHD index	'Behavioural difficulties'
	Reed 2013[437]	Oppositional behaviour, cognitive problems, hyperactivity, ADHD index	Behavioural problems, ADHD
Developmental Behaviour Checklist	Herring 2006[411]	–	Child behavioural and emotional problems
	Mooney 2006[311]	–	'Repetitive behaviour'
	Remington 2007[358]	–	'Child behaviour'
	Roberts 2011[405]	–	'Adaptive functioning and psychopathology'
	Tonge 2012[425]	–	Severity of autism
Home Situations Questionnaire (HSQ)	Bearss 2013[278]	–	Non-compliance in children
Nisonger Child Behavior Rating Scales	Remington 2007[358]	Positive Social Subscale	'Child behaviour'
Parent Target Problems	Bearss 2013[278]	–	Most pressing or important child needs
Pre-School Behavior Checklist	Rickards 2009[423]	–	'Behaviour'
Behaviour Style Questionnaire–Chinese version (Xu 1979)[a]	Chuang 2012[383]	–	Children's temperament
Coded observation of child behaviour problems[b]	Robbins 1992[446]	–	'Child behaviour problems'
Functional behaviour assessment interview (O'Neill *et al.* 1997)[c]	Reese 2005[447]	Gain attention, escape demand, gain item	'Disruptive behaviours'
Parent Survey[c]	Arick 2003[388]	–	Communication, social interaction, behaviour, parents' satisfaction
Video coding procedures (for children and parents)[d]	Bryce 2013[448]	–	–

ADHD, attention deficit hyperactivity disorder; N/A, not available.
a Non-UK.
b Pre-1995.
c Tools developed ad hoc.
d Observational coding.

Habit problems	Paper	Subscales used	Outcome(s) measured according to the author
Child Behavior Checklist (CBCL)	Smith 2000[413]	Social withdrawal, somatisation, anxiety/depression, social problems, thought problems, attention problems, delinquency, aggression	'Socioeconomic functioning'
	Baker 2010[397]	–	'Child behaviour problems'
	Peters-Scheffer 2010[421]	Behavioural problem scale	'Emotional and behavioural problems'
	Smith 2010[359]	Total problems, internalising problems, externalising problems, aggressive behavioural	'Behavioural problems'
	Taylor 2012[436]	Internalising problems, externalising problems, total problems composite	'Internalising and externalising behaviours in children'
	Hartley 2009[323]	–	Emotionally reactive, anxious/depressed, somatic complaints, sleep problems, attention problems, aggressive behaviour
Sense and Self-Regulation Checklist (SSC)	Silva 2009[226]	–	'Parent questionnaire (on) changes in sensory impairment, appetite, digestion, and sleep'
	Silva 2011[301]	Sense, self-regulation	'Sensory and self-regulatory symptoms commonly reported by parents'
Sleep Diaries[a]	Escalona 2001[271]	–	Amount of fussing, restlessness, crying, self-stimulating behaviour, number of times the child left the bed

a Tools developed ad hoc.

Learning	Paper	Subscales used	Outcome(s) measured according to the author
Autism Screening Instrument for Educational Planning (ASIEP)	Arick 2003[388]	Autism Behavior Checklist, sample of vocal behaviour, social interaction assessment, educational assessment	Educational progress
Extended Basic Academic Skills Assessment System	Arick 2003[388]	–	Educational progress in reading, writing and maths
Wechsler Individualised Achievement Test	Smith 2000[413]	–	'Academic achievement'
Student Learning Profile[a]	Arick 2003[388]	Expressive language, receptive language, daily routines, pre-academics, play behaviour, social interaction behaviour	Progress on written curriculum-based programmes; how the participants requested wants or needs
Classroom Observation Form[b]	Arick 2003[388]	–	Child's involvement level in classroom activities

a Tools developed ad hoc.
b Observational coding.

Daily living skills	Paper	Subscales used	Outcome(s) measured according to the author
Functional Independence Measure for Children (WeeFIM)	Jasmin 2009[384]	–	DLS
Vineland Adaptive Behavior Scales-Classroom version (VABS-Classroom)	Goin-Kochel 2007[427]	Communication, DLS, socialisation, motor skills	Communication skills, DLS, socialisation skills, motor skills
Vineland Adaptive Behavior Scales (VABS)	Aldred 2004[318]	Communication, DLS, socialisation	'Communication, daily living skills, and socialisation'
	Anan 2008[396]	Communication, DLS, socialisation, motor skills	Adaptive functioning
	Andersson 2013[409]	–	Adaptive skills
	Arick 2003[388]	–	Adaptive behaviour
	Baghdadli 2012[339]	Communication, DLS, socialisation	Adaptive behaviours
	Bearss 2013[278]	–	Communication, DLS, socialisation, motor skills
	Ben Itzchak 2011[320]	Communication, DLS, socialisation, motor skills	Adaptive skills
	Bennett 2008[296]	Social, communication, DLS	Personal and social sufficiency
	Carlsson 2013[390]	Motor skills domain	Motor function
	Cassidy 2008[348]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Dawson 2010[321]	Communication, DLS, socialisation, motor skills	'Social, communication, motor, and daily living skills'
	Eapen 2013[357]	–	Communication – expressive and receptive, DLS, socialisation, motor skills
	Eikeseth 2009[410]	–	'Adaptive behaviours'
	Eldevik 2012[414]	Adaptive behaviour composite, communication, daily living, socialisation	Adaptive behaviour
	Eriksson 2013[415]	–	Adaptive skills
	Gabriels 2007[416]	Communication, DLS, socialisation, motor skills, adaptive behaviour composite	Adaptive behaviour skills
	Green 2010[253]	–	'Adaptive functioning in school beyond the family'
	Grindle 2012[417]	–	Adaptive skills, socialisation, communication, DLS, motor skills
	Hedvall 2013[418]	Communication, DLS, socialisation, motor skills	–
	Herring 2006[411]	Derived Adaptive Behaviour Composite (ABC) standard score	Adaptive behaviour
	Honey 2008[307]	Communication, socialisation	'Children's abilities'
	Hudry 2010[233]	Receptive language, expressive language	'Receptive and expressive language skills'
	Jasmin 2009[384]	DLS	DLS

Daily living skills	Paper	Subscales used	Outcome(s) measured according to the author
	Jonsdottir 2007[341]	Composite	Adaptive behaviour in communication, DLS, socialisation and motor skills
	Klintwall 2012[427]	–	'Treatment gains . . . treatment outcomes'
	Landa 2012[224]	Communication domain standard score	Communication skills
	Lerna 2012[325]	–	Child communication, social abilities
	Lloyd 2013[400]	Communication, DLS, socialisation, motor skills	Communication, DLS, social skills, motor development
	Luyster 2008[129]	Motor, communication	Children's personal and social sufficiency in communication (receptive, expressive, written), DLS (personal, domestic, community), socialisation (interpersonal relationships, play and leisure, time, coping skills) and motor skills (gross, fine)
	Magiati 2007[308]	Communication, DLS, socialisation	Adaptive behaviour
	Magiati 2011[309]	Communication, DLS, socialisation, composite	Adaptive behaviour
	Mayo 2013[310]	Communication, DLS, socialisation, motor skills	Adaptive functioning
	McConkey 2010[349]	Communication, DLS, socialisation, motor skills	Communication, DLS, socialisation and motor skills.
	Munson 2006[420]	Socialisation, communication	'Socialisation and communication skills'
	Munson 2008[312]	Social, communication, DLS, motor skills	'Adaptive behaviours'
	O'Donnell 2012[386]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Osborne 2008[350]	Communication, DLS, socialisation, motor skills	'Day-to-day adaptive functioning'
	Osborne 2009[351]	Communication, DLS, socialisation, motor skills	'Adaptive behavioural functioning'
	Peters-Scheffer 2010[421]	Communication, DLS, socialisation	'Adaptive behaviour'
	Poon 2012[401]	Communication	'Communication'
	Pry 2005[314]	Communication, DLS, socialisation	'Child's knowledge about the social norms, conventions, and scripts that govern social life at all levels'
	Ray-Subramanian 2011[327]	Communication, DLS, socialisation, motor skills	'Adaptive skills'
	Reed 2007[352]	Communication, DLS, socialisation, motor skills	'Adaptive functioning'
	Reed 2007[353]	Communication, DLS, socialisation, motor skills	'Adaptive functioning'

Daily living skills	Paper	Subscales used	Outcome(s) measured according to the author
	Reed 2012[354]	Communication, DLS, socialisation, motor skills	Day-to-day adaptive behaviour
	Remington 2007[358]	Socialisation, communication, DLS, motor skills	'Adaptive skills'
	Restall 1994[422]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Rickards 2009[423]	–	'Communication, daily living skills, socialisation and motor skills'
	Roberts 2011[405]	–	'Communication and social skills'
	Rogers 2012[317]	Communication, DLS, socialisation, motor skills	Adaptive behaviour
	Ruble 2008[424]	Socialisation, communication	'Adaptive functioning'
	Salt 2002[372]	Communication, DLS, socialisation, motor skills	'Communication, daily living skills, socialisation and motor skills'
	Schertz 2013[402]	Communication	Adaptive behaviour
	Silva 2007[299]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Silva 2008[300]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Smith 2000[413]	Communication, DLS, socialisation	'Adaptive functioning'
	Smith 2010[359]	Communication, DLS, socialisation, motor skills	'Language/communication', 'adaptive behaviour'
	Stahmer 2004[355]	Communication, DLS, socialisation, motor skills	Child adaptive functioning
	Stone 1999[346]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Strauss 2012[329]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour functioning'
	Szatmari 2000[302]	Socialisation, communication	'Social skills' and 'language'
	Tonge 2012[425]	–	Adaptive behaviour
	Toth 2006[284]	Communication	'Communication skills'
	VanMeter 1997[426]	Communication, DLS, socialisation	'Social, communication, and daily living skills'
	Ventola 2007[332]	Socialisation, communication, DLS, motor skills	'Adaptive functioning'
	Werner 2005[316]	Communication, DLS, socialisation, motor skills	'Developmental outcomes'
	Zachor 2010[335]	Communication, DLS, socialisation motor skills	'Adaptive functioning'
Video coding of feeding behaviour[a]	Brisson 2012[449]	–	–

DLS, daily living skills.
a Observational coding.

Global measure of function	Paper	Subscales used	Outcome(s) measured according to the author
Ages and Stages Questionnaire (ASQ)	Feldman 2012[104]	Communication, gross motor, fine motor, problem solving, personal–social, overall	Infant development
Assessment of Basic Language and Learning Skills (ABLLS)	Goin-Kochel 2007[427]	Language, social, academic, self-help, motor, composite	Language, social/play, academics, self-help and motor skills
	Grindle 2012[417]	–	Learning skills, language, social skills and play, academic, self-help, motor-skills
	Gupta 2009[303]	–	Language and learning skills
Assessment, Evaluation and Programming System (AEPS)	Schwartz 2004[450]	Adaptive, cognitive, social communication, gross motor, fine motor	'Developmental progress'
Behavior Assessment System for Children-Second Edition (BASC-2)	Hill-Chapman 2013[434]	–	Atypicality of symptoms
Brigance Diagnostic Inventory of Early Development	Travers 2011[438]	Alphabet Recognition Assessments	'Alphabet Recognition'
Developmental Profile	Malhi 2011[342]	Academic	Developmental assessment. Developmental quotient was derived from the academic subscale
Early Development Interview	Werner 2005[316]	–	'Early Developmental Course'
Early Intervention Developmental Profile (EIDP)	Jocelyn 1998[298]	Cognition, language, perceptual/fine motor, gross motor, social–emotional, self-care	–
Early Learning Accomplishment Profile (E-LAP)	Virues-Ortega 2013[451]	–	Fine and gross motor, cognitive, language, self-care and social skills
Functional Emotional Developmental Questionnaire	Pajareya 2012[343]	–	Developmental rating of the children
	Pajareya 2011[344]	–	'Developmental rating' and 'fundamental development'
Learning Accomplishment Profile-Diagnostic, Third Edition (LAP-D)	Virues-Ortega 2013[451]	–	Fine and gross motor, cognitive, language, self-care and social skills
Paediatric Daily Occupation Scale	Hsieh 2013[452]	–	Occupational performance
Preschool Developmental Profile (PSDP)	Jocelyn 1998[298]	Cognition, language, perceptual/fine motor, gross motor, social/emotional, self-care	–
Psychoeducational Profile-Revised (PEP-R)	Delmolino 2006[432]	Imitation, perception, eye–hand integration, fine motor, gross motor, cognitive verbal, cognitive performance	Cognitive development, general development
	Herring 2006[411]	–	Developmental age

Global measure of function	Paper	Subscales used	Outcome(s) measured according to the author
	McConkey 2010[349]	Imitation, perception, fine motor skills, gross motor skills, eye–hand co-ordination, non-verbal conceptual ability, verbal conceptual ability	Learning style, strengths and deficits
	Osborne 2008[350]	Imitation, perception, fine motor skills, gross motor skills, eye–hand co-ordination, non-verbal conceptual ability, verbal conceptual ability	'Typical strengths and characteristic weaknesses of children with ASD'
	Ozonoff 1998[453]	Imitation, perception, fine motor skills, gross motor skills, eye–hand co-ordination, non-verbal conceptual ability, verbal conceptual ability	'Typical strengths and the characteristic weaknesses of children with autism'
	Reed 2007[352]	Imitation, perception, fine motor skills, gross motor skills, eye–hand co-ordination, non-verbal conceptual ability, verbal conceptual ability	'Developmental functioning'
	Reed 2007[353]	Imitation, perception, fine motor skills, gross motor skills, eye–hand co-ordination, non-verbal conceptual ability, verbal conceptual ability	'Developmental functioning'
	Reed 2012[354]	Imitation, perception, fine motor skills, gross motor skills, eye–hand co-ordination, non-verbal conceptual ability, verbal conceptual ability	Typical strengths and weaknesses of children on the autism spectrum
	Tonge 2012[425]	–	Cognitive development
Scales of Independent Behavior-Revised (SIB-R)	Keen 2010[363]	–	Adaptive and maladaptive behaviour: internalising behaviour, externalising behaviour and asocial behaviour
Vineland Adaptive Behavior Scales-Classroom version (VABS-Classroom)	Goin-Kochel 2007[427]	Communication, DLS, socialisation, motor skills	Communication skills, DLS, socialisation skills, motor skills
Vineland Adaptive Behavior Scales (VABS)	Aldred 2004[318]	Communication, DLS, socialisation	'Communication, daily living skills, and socialisation'
	Anan 2008[396]	Communication, DLS, socialisation, motor skills	Adaptive functioning
	Andersson 2013[409]	–	Adaptive skills
	Arick 2003[388]	–	Adaptive behaviour
	Baghdadli 2012[339]	Communication, DLS, socialisation	Adaptive behaviours
	Bearss 2013[278]	–	Communication, DLS, socialisation, motor skills
	Ben Itzchak 2011[320]	Communication, DLS, socialisation, motor skills	Adaptive skills
	Bennett 2008[296]	Social, communication, DLS	Personal and social sufficiency

Global measure of function	Paper	Subscales used	Outcome(s) measured according to the author
	Carlsson 2013[390]	Motor skills domain	Motor function
	Cassidy 2008[348]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Dawson 2010[321]	Communication, DLS, socialisation, motor skills	'Social, communication, motor, and daily living skills'
	Eapen 2013[357]	–	Communication – expressive and receptive, DLS, socialisation, motor skills
	Eikeseth 2009[410]	–	'Adaptive behaviours'
	Eldevik 2012[414]	Adaptive behaviour composite, communication, daily living, socialisation	Adaptive behaviour
	Eriksson 2013[415]	–	Adaptive skills
	Gabriels 2007[416]	Communication, DLS, socialisation, motor skills, adaptive behaviour composite	Adaptive behaviour skills
	Green 2010[253]	–	'Adaptive functioning in school beyond the family'
	Grindle 2012[417]	–	Adaptive skills, socialisation, communication, DLS, motor skills
	Hedvall 2013[418]	Communication, DLS, socialisation, motor skills	–
	Herring 2006[411]	Derived Adaptive Behaviour Composite (ABC) standard score	Adaptive behaviour
	Honey 2008[307]	Communication, socialisation	'Children's abilities'
	Hudry 2010[233]	Receptive language, expressive language	'Receptive and expressive language skills'
	Jasmin 2009[384]	DLS	DLS
	Jonsdottir 2007[341]	Composite	Adaptive behaviour in communication, DLS, socialisation, and motor skills
	Klintwall 2012[427]	–	'Treatment gains . . . treatment outcomes'
	Landa 2012[224]	Communication domain standard score	Communication skills
	Lerna 2012[325]	–	Child communication, social abilities
	Lloyd 2013[400]	Communication, DLS, socialisation, motor skills	Communication, DLS, social skills, motor development
	Luyster 2008[129]	Motor, communication	Children's personal and social sufficiency in communication (receptive, expressive, written), DLS (personal, domestic, community), socialisation (interpersonal relationships, play and leisure, time, coping skills), and motor skills (gross, fine)

Global measure of function	Paper	Subscales used	Outcome(s) measured according to the author
	Magiati 2007[308]	Communication, DLS, socialisation	Adaptive behaviour
	Magiati 2011[309]	Communication, DLS, socialisation, composite	Adaptive behaviour
	Mayo 2013[310]	Communication, DLS, socialisation, motor skills	Adaptive functioning
	McConkey 2010[349]	Communication, DLS, socialisation, motor skills	Communication, DLS, socialisation and motor skills
	Munson 2006[420]	Socialisation, communication	'Socialisation and communication skills'
	Munson 2008[312]	Social, communication, DLS, motor skills	'Adaptive behaviours'
	O'Donnell 2012[386]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Osborne 2008[350]	Communication, DLS, socialisation, motor skills	'Day-to-day adaptive functioning'
	Osborne 2009[351]	Communication, DLS, socialisation, motor skills	'Adaptive behavioural functioning'
	Peters-Scheffer 2010[421]	Communication, DLS, socialisation	'Adaptive behaviour'
	Poon 2012[401]	Communication	'Communication'
	Pry 2005[314]	Communication, DLS, socialisation	'Child's knowledge about the social norms, conventions, and scripts that govern social life at all levels'
	Ray-Subramanian 2011[327]	Communication, DLS, socialisation, motor skills	'Adaptive skills'
	Reed 2007[352]	Communication, DLS, socialisation, motor skills	'Adaptive functioning'
	Reed 2007[353]	Communication, DLS, socialisation, motor skills	'Adaptive functioning'
	Reed 2012[354]	Communication, DLS, socialisation, motor skills	Day-to-day adaptive behaviour
	Remington 2007[358]	Socialisation, communication, DLS, motor skills	'Adaptive skills'
	Restall 1994[422]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Rickards 2009[423]	–	'Communication, daily living skills, socialisation and motor skills'
	Roberts 2011[405]	–	'Communication and social skills'
	Rogers 2012[317]	Communication, DLS, socialisation, motor skills	Adaptive behaviour
	Ruble 2008[424]	Socialisation, communication	'Adaptive functioning'
	Salt 2002[372]	Communication, DLS, socialisation, motor skills	'Communication, daily living skills, socialisation and motor skills'

Global measure of function	Paper	Subscales used	Outcome(s) measured according to the author
	Schertz 2013[402]	Communication	Adaptive behaviour
	Silva 2007[299]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Silva 2008[300]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Smith 2000[413]	Communication, DLS, socialisation	'Adaptive functioning'
	Smith 2010[359]	Communication, DLS, socialisation, motor skills	'Language/communication', 'adaptive behaviour'
	Stahmer 2004[355]	Communication, DLS, socialisation, motor skills	Child adaptive functioning
	Stone 1999[346]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour'
	Strauss 2012[329]	Communication, DLS, socialisation, motor skills	'Adaptive behaviour functioning'
	Szatmari 2000[302]	Socialisation, communication	'Social skills' and 'language'
	Tonge 2012[425]	–	Adaptive behaviour
	Toth 2006[284]	Communication	'Communication skills'
	VanMeter 1997[426]	Communication, DLS, socialisation	'Social, communication, and daily living skills'
	Ventola 2007[332]	Socialisation, communication, DLS, motor skills	'Adaptive functioning'
	Werner 2005[316]	Communication, DLS, socialisation, motor skills	'Developmental outcomes'
	Zachor 2010[335]	Communication, DLS, socialisation, motor skills	'Adaptive functioning'
Social Adaptive Development Quotient Scale (ADQ)[a]	Zhang 2012[303]	–	'Motor, daily life, language development, personal orientation, social responsibility, time and space, labour skills, and economic activity'

DLS, daily living skills.
a Non-UK.

Global measure of outcome	Paper	Subscales used	Outcome(s) measured according to the author
Autism Treatment Evaluation Checklist (ATEC)	Goin-Kochel 2007[427]	Speech/language/communication, sociability, sensory/cognitive awareness, health/physical/behaviour, composite	Speech/language/communication, sociability, health/physical/behaviour, sensory/cognitive awareness
Behavioral Summarized Evaluation-Revised (BSE-R)	Receveur 2005[337]	–	'Interaction disorders'
Behavioral Summarized Evaluation (BSE)	Maestro 2005[338]	–	'Severity of behavioural problems'
Clinical Global Impression – Improvement Scale	Bearss 2013[278]	–	Overall improvement
	Oosterling 2010[326]	–	'General improvement'
Infant Behavioral Summarized Evaluation (IBSE)	Adrien 1992[90]	–	General autism characteristics
	Receveur 2005[337]	–	'Early signs of autism' and 'behavioural evaluation'
Pervasive Developmental Disorders Behavior Inventory (PDDBI)	Silva 2009[226]	Receptive/expressive social communication abilities composite, approach/withdrawal problems composite, sensory	'Social and language abilities and maladaptive behaviour'
	Silva 2011[301]	Sensory, maladaptive behaviour, social/language/communication abilities	'Social and language abilities and maladaptive behaviour'

Subjective well-being	Paper	Subscales used	Outcome(s) measured according to the author
Kiddie–Infant Descriptive Instrument for Emotional States (KIDIES)[a]	Trad 1993[454]	Happiness, attention to persons, attention to things	'Affective and behavioural dimensions'

a Pre-1995.

Social Inclusion	Paper	Subscales used	Outcome(s) measured according to the author
School Liking and Avoidance Questionnaire	Jahromi 2013[431]	–	School engagement
Teacher Rating Scale of School Adjustment	Jahromi 2013[431]	–	Behavioural school engagement

Interaction Style	Paper	Subscales used	Outcome(s) measured according to the author
Functional Emotional Assessment Scale	Pajareya 2012[343]	–	Changes in children's functional development
	Pajareya 2011[344]	–	'Changes in children's functional development'
NICHD Early Child Care Network scales	Baker 2010[397]	Parenting subscale	'Maternal sensitivity'
Coded observation of social behaviour[a]	Meirsschaut 2011[442]	Child's level of play, mother's play stimulation, child's social initiatives, child responses, mother's social initiatives, mother's responses	'Social behaviour'
Coding of videos[a]	Flippin 2011[406]	Parent play responsiveness, parent verbal responsiveness, child object play (exploratory, relational, functional, symbolic)	Object play skills, parent responsiveness
Parental skills – video ratings[a]	Oosterling 2010[326]	Supportive presence, respect for the child's autonomy, effective structure and limit setting, quality of instructions, non-hostility	'Quality of parental skills in their interaction with their child'
Parent–child free play[a]	Freeman 2013[443]	–	Play acts, play schemes
Parent–child interaction[a]	Green 2010[253]	Parent synchrony, child initiations, mutual shared attention	Parent–child interaction during naturalistic play
Parent–Child Interaction measure[a]	Aldred 2012[319]	–	Parent–child interaction
Preschool teacher–child play[a]	Kaale 2012[294]	–	Joint attention and joint engagement
Social Interaction Rating Scale[a]	Ruble 2008[424]	Contingency, directiveness, initiation towards the child, movement with the child, affect, maintenance of interaction with the child	'Parent interaction'

a Observational coding.

Parent stress	Paper	Subscales used	Outcome(s) measured according to the author
Autism Parenting Stress Index (PSI) (APSI)	Silva 2011[301]	–	'Parent stress'
Beck Anxiety Inventory	Davis 2008[455]	–	Anxiety in parents
Center for Epidemiologic Studies Depression Inventory	Davis 2008[455]	–	–
	Taylor 2012[436]	–	'Caregiver depressive symptoms'
General Health Questionnaire (GHQ)	Herring 2006[411]	–	Parental mental health
	McConkey 2010[349]	Somatic, anxiety	Parents' psychiatric morbidity
	Tonge 2005[456]	Somatic symptoms, anxiety and insomnia, social dysfunction, severe depression	'Parental mental health'
Hospital Anxiety and Depression Scale (HADS)	Remington 2007[358]	Depression, anxiety	'Parental mental health'
Parenting Stress Index-Short Form (PSI-SF)	Strauss 2012[329]	Parent distress, dysfunctional parent–child interaction, child difficulty	'Parental stress'
Parenting Sense of Competence (PSOC)	Keen 2007[364]	–	Parental satisfaction and efficacy
	Keen 2010[363]	–	Parental satisfaction and efficacy
Parenting Stress Index (PSI)	Aldred 2004[318]	Parent distress, dysfunctional parent–child interaction, child difficulty	'(Parent) total stress'
	Baker-Ericzen 2005[457]	Child domain, parent domain	Parent stress
	Keen 2010[363]	–	Stress resulting from parental perceptions of the child's contribution to the parent–child relationship (child stress), the impact of the parental role on the parent with respect to psychological well-being, health, marital and other relationships (parental stress)
	Roberts 2011[405]	–	'Stress'
	Salt 2002[372]	Parent distress, dysfunctional parent–child interaction, child difficulty	'Total stress'
Parenting Stress Index-Short Form (PSI-SF)	Bendixen 2011[458]	–	Parent stress
	Davis 2008[455]	–	Parent stress
	Hill-Chapman 2013[434]	–	Levels of stress in parent–child relationship
	Minjarez 2013[459]	Parent distress, dysfunctional parent–child interaction, child difficulty	Parent stress
	Wang 2013[460]	Parent distress, dysfunctional parent–child interaction, child difficulty	Parenting stress
	Wong 2010[333]	Parent distress, dysfunctional parent–child interaction, child difficulty	'Parent stress'

Parent stress	Paper	Subscales used	Outcome(s) measured according to the author
Positive and Negative Affect Scale (PANAS)	Hsieh 2013[452]	Positive affect, negative affect	–
Questionnaire on Resources and Stress-Friedrich Short Form (QRS-F)	Cassidy 2008[348]	Parent and family problems, pessimism	'Parent stress'
	McConkey 2010[349]	–	Impact of a developmentally delayed or 'mentally retarded child' on the family
	Osborne 2008[350]	Parent and family problems, pessimism, child characteristics, physical incapacity	'Parent stress'
	Osborne 2009[351]	Parent and family problems, pessimism, child characteristics, physical incapacity	'Parenting stress'
	Remington 2007[358]	Parent and family problems subscale	'Parental stress'
	Rickards 2009[423]	–	'Adaptation and coping in families caring for a child with a disability'
Questionnaire on Resources and Stress-Friedrich Short Form (QRS-F)	Reed 2013[437]	Parent and family problems, pessimism, child characteristics, physical incapacity	Parental perceptions of the impact of a developmentally delayed, or chronically ill, child on other family members
Reaction to Diagnosis Interview	Oppenheim 2012[461]	–	–
	Wachtel 2008[462]	–	'Reactions, beliefs, and memories of the diagnostic experience'
Satisfaction with Life Scale	Hsieh 2013[452]	–	Subjective well-being
Stress Arousal Checklist	Jocelyn 1998[298]	–	Stress, arousal
Symptom Checklist-90-Revised (SCL-90)	Bennett 2012[304]	Depression, interpersonal sensitivity, somatisation	Maternal depression
Daily occupational experience[a]	Hsieh 2013[452]	Productive, restoration, pleasure	Productive, restoration and pleasure experiences in daily occupations
Parent–child Interaction Rating Scales[a]	Wachtel 2008[462]	–	'Parent–child interaction'
Parenting stress thermometer[a]	Tonge 2005[456]	–	'General level of stress'
Self-constructed questionnaire[a]	Farmer 2013[463]	–	Parent knowledge of autism, parents understanding of autism, parents confidence in managing autistic child
Stress thermometer[a]	Herring 2006[411]	–	Parenting stress

a Tools developed ad hoc.

Family quality of life	Paper	Subscales used	Outcome(s) measured according to the author
Beach Family Quality of Life Questionnaire	Roberts 2011[405]	–	'Quality of life'
Family Adaptability and Cohesion Evaluation Scales	Bendixen 2011[458]	Cohesion, adaptability	Family cohesion, family adaptability, perceived and ideal family functioning
Family Assessment Device	Herring 2006[411]	–	Family functioning
	Tonge 2005[456]	–	'General family function'
Family Assessment Measure (Skinner *et al.* 1983)	Jocelyn 1998[298]	–	Task accomplishment, role performance, communication, affective expression, affective involvement, control
Family Empowerment Scale	Minjarez 2013[459]	Family empowerment, service empowerment, community/political empowerment	Level of empowerment and the way in which it is expressed
	Rickards 2009[423]	–	'Family, service and community level empowerment'
Family Support Scale	Rickards 2009[423]	–	'Social support'
Kansas Inventory of Parental Perceptions	Remington 2007[358]	Positive contributions subscale	'Parent perceptions'
Parenting Alliance Inventory	Hill-Chapman 2013[434]	–	Self-focused parenting alliance, child-focused parenting alliance
Familial Resources Index[a]	Baghdadli 2012[339]	–	Family functioning and coping behaviours
TRE-ADD Autism Quiz (TAQ)[a]	Jocelyn 1998[298]	–	Knowledge about autism
Family Satisfaction Questionnaire[a]	Smith 2000[413]	–	'Parent evaluation'

a Tools developed ad hoc.

Appendix 6 Additional information on *Chapter 4* search methodology

COnsensus-based Standards for the selection of health status Measurement INstruments translation (for Ovid)

instrumentation.sh. OR methods.sh. OR Validation Studies.pt. OR Comparative Study.pt. OR psychometrics/ OR psychometr*.ab,ti. OR clinimetr*.tw. OR clinometr*.tw. OR 'Outcome Assessment (Health Care)'/ OR outcome assessment.ab,ti. OR outcome measure*.tw. OR observer variation/ OR observer variation.ab,ti. OR Health Status Indicators/ OR reproducibility of results/ OR reproducib*.ab,ti. OR discriminant analysis/ OR reliab*.ab,ti. OR unreliab*.ab,ti. OR valid*.ab,ti. OR coefficient.ab,ti. OR homogeneity.ab,ti. OR homogeneous.ab,ti. OR internal consistency.ab,ti. OR (cronbach*.ab,ti. AND (alpha.ab,ti. OR alphas.ab,ti.)) OR (item.ab,ti. AND (correlation*.ab,ti. OR selection*.ab,ti. OR reduction*.ab,ti.)) OR agreement.ab,ti. OR precision.ab,ti. OR imprecision.ab,ti. OR precise values.ab,ti. OR test-retest.ab,ti. OR (test.ab,ti. AND retest.ab,ti.) OR (reliab*.ab,ti. AND (test.ab,ti. OR retest.ab,ti.)) OR stability.ab,ti. OR interrater.ab,ti. OR inter-rater.ab,ti. OR intrarater.ab,ti. OR intra-rater.ab,ti. OR intertester.ab,ti. OR inter-tester.ab,ti. OR intratester.ab,ti. OR intra-tester.ab,ti. OR interobserver.ab,ti. OR inter-observer.ab,ti. OR intraobserver.ab,ti. OR intraobserver.ab,ti. OR intertechnician.ab,ti. OR inter-technician.ab,ti. OR intratechnician.ab,ti. OR intra-technician.ab,ti. OR interexaminer.ab,ti. OR inter-examiner.ab,ti. OR intraexaminer.ab,ti. OR intra-examiner.ab,ti. OR interassay.ab,ti. OR inter-assay.ab,ti. OR intraassay.ab,ti. OR intra-assay.ab,ti. OR interindividual.ab,ti. OR inter-individual.ab,ti. OR intraindividual.ab,ti. OR intra-individual.ab,ti. OR interparticipant.ab,ti. OR inter-articipant.ab,ti. OR intraparticipant.ab,ti. OR intra-participant.ab,ti. OR kappa.ab,ti. OR kappa's.ab,ti. OR kappas.ab,ti. OR repeatab*.ab,ti. OR ((replicab*.ab,ti. OR repeated.ab,ti.) AND (measure.ab,ti. OR measures.ab,ti. OR findings.ab,ti. OR result.ab,ti. OR results.ab,ti. OR test.ab,ti. OR tests.ab,ti.)) OR generaliza*.ab,ti. OR generalisa*.ab,ti. OR concordance.ab,ti. OR (intraclass.ab,ti. AND correlation*.ab,ti.) OR discriminative.ab,ti. OR known group.ab,ti. OR factor analysis.ab,ti. OR factor analyses.ab,ti. OR dimension*.ab,ti. OR subscale*.ab,ti. OR (multitrait.ab,ti. AND scaling.ab,ti. AND (analysis.ab,ti. OR analyses.ab,ti.)) OR item discriminant.ab,ti. OR interscale correlation*.ab,ti. OR error.ab,ti. OR errors.ab,ti. OR individual variability.ab,ti. OR (variability.ab,ti. AND (analysis.ab,ti. OR values.ab,ti.)) OR (uncertainty.ab,ti. AND (measurement.ab,ti. OR measuring.ab,ti.)) OR standard error of measurement.ab,ti. OR sensitiv*.ab,ti. OR responsive*.ab,ti. OR ((minimal.ab,ti. OR minimally.ab,ti. OR clinical.ab,ti. OR clinically.ab,ti.) AND (important.ab,ti. OR significant.ab,ti. OR detectable.ab,ti.) AND (change.ab,ti. OR difference.ab,ti.)) OR (small*.ab,ti. AND (real.ab,ti. OR detectable.ab,ti.) AND (change.ab,ti. OR difference.ab,ti.)) OR meaningful change.ab,ti. OR ceiling effect.ab,ti. OR floor effect.ab,ti. OR Item response model.ab,ti. OR IRT.ab,ti. OR Rasch.ab,ti. OR Differential item functioning.ab,ti. OR DIF.ab,ti. OR computer adaptive testing.ab,ti. OR item bank.ab,ti. OR cross-cultural equivalence.ab,ti.

Search terms

Autism terms
Asd (not atrial septal defect)

Asperg*

Autis*

childhood schizophrenia

Kanner*

(PDD or PDD-NOS)

semantic-pragmatic disorder

pervasive developmental disorder?

exp Child Development Disorders, Pervasive/

Age group
Child*

infan*

kindergarten*

p?ediatric*

nursery

toddler*

(pre-school* or preschool*)

special needs

((primary or elementary or grammar) and school)

Measurement tool strategies

Sensory processing tools
(Infant Toddler Sensory Profile or Infant?Toddler Sensory Profile).ti,ab.

(Pervasive Developmental Disorders Behavio?r Inventory or pddbi or pdd Behavio?r Inventory).ti,ab.

(Sense and Self-Regulation Checklist).ti,ab.

((Sensory Profile or Short Sensory Profile or SSP) adj5 dunn).ti,ab.

or/1-4

Attention

(Achenbach Child Behavio?r Checklist or (Achenbach adj2 CBCL)).ti,ab.

Child Behavio?r Scale.ti,ab.

(Conner* Rating Scales adj2 revised).ti,ab.

Achenbach Child Behavio?r Check?list.ti,ab.

or/1-4

Emotional regulation tools

Conner* Parent Rating Scale.ti,ab.

(CPRS-R or (cprs* adj5 (autis* or asperger*))).ti,ab.

(DBC-P adj5 (autis* or asperger*)).ti,ab.

Developmental Behavio?r Checklist Primary Carer Version.ti,ab.

(Infant Toddler Social adj2 Emotional Assessment).ti,ab.

bitsea.ti,ab.

Toddler Behavio?r Assessment Questionnaire.ti,ab.

TBAQ.ti,ab.

or/1-8

Physical skills

Peg Moving Task.ab,ti.

annett? peg?.ti,ab.

(Assessment, Evaluation adj3 Programming System).ti,ab.

aeps test.ti,ab.

(Assessment, Evaluation adj3 Program?ing System).ti,ab.

Beery Visual-Motor Integration Test.ti,ab.

beery vmi.ti,ab.

(vmi adj3 test).ti,ab.

(Infant Motor Maturity adj3 Atypicality Coding Scales).ti,ab.

IMMACS.ti,ab.

Infant Motor Maturity.ti,ab.

Atypicality Coding Scales.ti,ab.

Mullen Scales of Early Learning.ti,ab.

msel.ti,ab.

Peabody Developmental Motor Scales.ti,ab.

pdms-2.ti,ab.

Psycho-educational Profile.ti,ab.

Psycho-educational Profile-revised.ti,ab.

(pep-r adj10 (autis* or asperg*)).ti,ab.

(Ages adj3 Stages Questionnaire).ti,ab.

ASQs.ti,ab.

Vineland Adaptive Behavio?r Scales.ti,ab.

vineland-ii.ti,ab.

VABS-II.ti,ab.

VABS2.ti,ab.

or/1-25

Play

Structured Play Assessment.ti,ab.

Symbolic Play Test.ti,ab.

Test of Pretend Play.ti,ab.

or/1-3

Social communications

Autism Screening Instrument for Educational Planning.ti,ab.

(ASIEP-2 or ASIEP-3).ti,ab.

ASIEP?.ti,ab.

Early Social Communication Scales-Abridged.ti,ab.

Early Social Communication Scales Abridged.ti,ab.

Ritvo-Freeman Real Life Rating Scale.ti,ab.

(RLRS adj10 freeman).ti,ab.

Real Life Rating Scale.ti,ab.

Social Communication Behavio?r Codes.ti,ab.

Social Communication Behavior Codes.ti,ab.

or/1-10

Social functioning

ABLLS-R.ti,ab,tm.

(Assessment of basic Language adj2 Learning Skills).ti,ab,tm.

Pervasive Developmental Disorder? Behavio?r* Inventory.ti,ab,tm.

pdd behavio?r* inventory.ti,ab,tm.

Social Behavio?r* Rating Scale?.ti,ab,tm.

(ssrs adj10 (autis* or asperg*)).ti,ab.

Student Learning Profile.ti,ab,tm.

(vineland Adaptive Behavio?r* Scale? adj5 interview).ti,ab,tm.

(vineland Adaptive Behavio?r Scales adj5 (interview edition or survey form)).ti,ab,tm.

1or/1-9

Play

Structured Play Assessment.ti,ab,tm.

Symbolic Play Test?.ti,ab,tm.

Test? of Pretend Play.ti,ab,tm.

or/1-3

Behaviour

Behavio?r* Screening Questionnaire.ti,ab,tm.

(bsq adj10 (autis* or asperg* or screen*)).ti,ab.

bsq.tm.

Functional Behavio?r* Assessment Interview*.ti,ab,tm.

(Pre?school Behavio?r* Checklist* or Pre?school Behavio?r* Check list*).ti,ab,tm.

(pbcl adj10 (autis* or asperg* or asd)).ti,ab.

pbcl.tm.

Scale? of independent behavio?r* revised-early development form.ti,ab,tm.

Scale? of independent behavio?r* revised.ti,ab,tm.

SIB-R.ti,ab,tm.

(Scale* of independent behavio?r* adj2 revised).ti,ab,tm.

or/1-11

Habit problems

Brigance Diagnostic Inventory of Early Development.ti,ab.

Brigance Diagnostic Inventory of Early Development*.ti,ab,tm.

brigance diagnostic.ti,ab,tm.

or/1-3

Learning

Extended Basic Academic Skill? Assessment System.ti,ab,tm.

basic academic skill? assessment system.ti,ab,tm.

Wechsler Individuali* Achievement Test?.ti,ab,tm.

WIAT-II.ti,ab,tm.

or/1-4

Daily living skills

Functional Emotional Assessment Scale?.ti,ab,tm.

Functional Emotional Assessment Score?.ti,ab,tm.

Functional Independence Measure for children.ti,ab,tm.

Peabody Picture Vocabulary Test?.ti,ab,tm.

(FEAS or FIMC).tm. or PPVT*.ti,ab,tm.

or/1-4

Global measure of function

Autis* treatment Evaluation Checklist.ti,ab,tm.

Autis* treatment Evaluation Check list.ti,ab,tm.

ATEC.tm. or (atec adj10 (autis* or asperg* or asd)).ti,ab.

Clinical Global Impression Improvement scale?.ti,ab,tm.

nical Global Impression Improvement score?

CGI-I.tm. or (cgi-i adj10 (autis* or asperg* or asd)).ti,ab.

Functional Emotional Development* Questionnaire.ti,ab,tm.

fedq.tm. or (fedq adj10 (autis* or asperg* or asd)).ti,ab.

or/1-7

Parent stress

'Autism Parent* Stress Index'.ab,ti,tm.

apsi.tm.

(apsi adj10 (autis* or asperg* or asd)).ti,ab,tm.

General Health Questionnaire.ti,ab,tm.

ghq.tm. or (ghq adj10 (autis* or asperg* or asd)).ti,ab.

Parent* Stress Index.ti,ab,tm.

(Hospital Anxiety adj2 Depression Scale?).ti,ab,tm.

(Hospital Anxiety adj2 Depression Score?).ti,ab,tm.

HADS.tm. or (hads adj10 (autis* or asperg* or asd)).ti,ab.

(Questionnaire on Resources adj2 Stress).ti,ab,tm.

QRS-F.tm,ti,ab.

Symptom Checklist-90-Revised.ti,ab,tm.

Symptom Check list-90-Revised.ti,ab,tm.

SCL-90-R.ti,ab,tm.

beck anxiety inventory.ti,ab,tm.

bai.tm. or (bai adj10 (autis* or asperg* or asd)).ti,ab.

beck anxiety scale?.ti,ab,tm.

ck anxiety score?.ti,ab,tm.

Cent* for Epidemiologic Studies Depression Inventory.ti,ab,tm.

CES-D.tm. or (ces-d adj10 (autis* or asperg* or asd)).ti,ab.

Cent* for Epidemiologic Studies Depression scale?.ti,ab,tm.

Cent* for Epidemiologic Studies Depression score?.ti,ab,tm.

or/1-19

Family quality of life

(Family Adaptability adj2 Cohesion Evaluation Scale? ii).ti,ab,tm.

faces.tm. or (faces adj10 (autis* or asperg* or asd)).ti,ab.

facesii.tm. or (facesii adj10 (autis* or asperg* or asd)).ti,ab.

Family Assessment Device General Functioning Scale?.ti,ab,tm.

fad.tm. or (fad adj10 (autis* or asperg* or asd)).ti,ab.

Family Empowerment Scale?.ti,ab,tm.

Kansas Inventory of Parent* Perception?.ti,ab,tm.

McMaster Family Assessment Device?.ti,ab,tm.

Beach Family Quality of Life Questionnaire.ti,ab,tm.

Beach Centre Family Quality of Life Scale?.ti,ab,tm.

Beach Cent* Family Quality of Life Scale?.ti,ab,tm.

kipp.tm. or (kipp adj10 (autis* or asperg* or asd)).ti,ab.

fes.tm. or (fes adj10 (autis* or asperg* or asd)).ti,ab.

or/1-13

Language

Battelle Development* Inventory.ti,ab,tm.

bdi-2.ti,ab,tm.

British Picture Vocabulary Scale?.ti,ab,tm.

British Picture Vocabulary Score?.ti,ab,tm.

bpvs*.ti,ab,tm.

Expressive One-Word Picture Vocabulary Test?.ti,ab,tm.

eowpvt*.ti,ab,tm.

MacArthur Communicati* Development* Inventory.ti,ab,tm.

MacArthur Communicati* Development* scale?.ti,ab,tm.

MacArthur Communicati* Development* score?.ti,ab,tm.

Macarthur CDI.ti,ab,tm.

(cdi adj10 (autis* or asperg* or asd)).ti,ab.

McCarthy Scale? of Children* Abilit*.ti,ab,tm.

McCarthy Score? of Children* Abilit*.ti,ab,tm.

msca.tm. or (msca adj10 (autis* or asperg* or asd)).ti,ab.

Merrill-Palmer-Revised.ti,ab,tm.

m-p-r.tm. or (m-p-r adj10 (autis* or asperg* or asd)).ti,ab.

Pre?school Language Scale?.ti,ab,tm.

Pre?school Language Score?.ti,ab,tm.

Reynell Developmental Language Scale?.ti,ab,tm.

Reynell Developmental Language Score?.ti,ab,tm.

(NRDLS or RDLS).tm. or ((nrdls or rdls) adj10 (austis* or asperg* or asd)).ti,ab.

Sequenced Inventory of Communication Revised.ti,ab,tm.

Sequenced Inventory of Communication.ti,ab,tm.

sicd-r.ti,ab,tm.

Test? for Auditory Comprehension of Language.ti,ab,tm.

tacl*.tm. or (tacl* adj10 (autis* or asperg* or asd)).ti,ab.

Test? of Language Development.ti,ab,tm.

TOLD.tm. or (told adj10 (autis* or asperg* or asd)).ti,ab.

Pragmatic? Profile?.ti,ab,tm.

or/1-30

Cognitive abilities

Arthur* Adaptation of the Leiter* international Performance scale?.ti,ab,tm.

AALIPS.ti,ab,tm.

Arthur* Adaptation of the Leiter* international Performance score?.ti,ab,tm.

Bayley Scale? of Infant Development.ti,ab,tm.

BSID*.tm. or (bsid* adj10 (autis* or asperg* or asd)).ti,ab.

British Abilit* Scale?.ti,ab,tm.

British Abilit* Score?.ti,ab,tm.

Cattell Infant Intelligence.ti,ab,tm.

CIIS.tm. or (ciis adj10 (autis* or asperg* or asd)).ti,ab.

Development* Profile?.ti,ab,tm.

(Development* Profile? adj10 ahern).ti,ab,tm.

Griffith? Mental Development* Scale?.ti,ab,tm.

Griffith? Mental Development* Score?.ti,ab,tm.

GMDS*.tm. or (gmds* adj10 (autis* or asperg* or asd)).ti,ab.

Cattell? Infant Intelligence.ti,ab,tm.

Bayley? Scale? of Infant Development.ti,ab,tm.

(Leiter? International Performance Scale? Revised Visuali?ation adj2 reasoning Battery).ti,ab,tm.

Arthur? Adaptation of the Leiter? international Performance scale?.ti,ab,tm.

LEITER-R.ti,ab,tm.

Merrill Palmer Scale? of Mental Test?.ti,ab,tm.

Merrill Palmer Scale? of Mental score?.ti,ab,tm.

Merrill Palmer Scale? of Mental scale?.ti,ab,tm.

Snijder? Oomen? Non?verbal Intelligence Test?.ti,ab,tm.

SON-test?.ti,ab,tm.

son-r.ti,ab,tm.

Stanford Binet? Intelligence Scale?.ti,ab,tm.

Stanford Binet? Intelligence Score?.ti,ab,tm.

sb5.tm. or (sb5 adj10 (autis* or asperg* or asd)).ti,ab.

Wechsler? Intelligence Scale? for Children Revised.ti,ab,tm.

(Wechsler? Pre?school adj2 Primary Scale? of Intelligence Revised).ti,ab,tm.

Wechsler? Intelligence Score? for Children Revised.ti,ab,tm.

(Wechsler? Pre?school adj2 Primary Score? of Intelligence Revised).ti,ab,tm.

WPPSI.ti,ab,tm.

or/1-33

Iterative search: August 2013

((Behavio?r* Assessment System? adj2 Children) or BASC or BASC-2 or BASC2).ti,ab,tm.

(Home Situation? Questionnaire or HSQ).ti,ab,tm.

(Target adj1 (Problem* or Symptom* or Behavio?r*)).ti,ab,tm.

Behavio?r* Rating? Inventor* of Executive Function* Pre?school.ti,ab,tm.

BRIEF-P.ti,ab,tm.

(Children* Global Assessment* adj1 (Scale* or score*)).ti,ab,tm.

cgas.ti,ab,tm.

Emotion* Regulation Check?list*.ti,ab,tm.

ERC.ti,ab,tm.

Or/1-9

Parent* Alliance Inventor*.ti,ab,tm.

(PAI adj10 (autis* or asperg* or asd)).ti,ab,tm.

famil* assessment* measur*.ti,ab,tm.

(FAM adj10 (autis* or asperg* or asd)).ti,ab,tm.

(Famil* Support Scale* or Famil* Support score*).ti,ab,tm.

((P?ediatric Daily Occupation* Scale*) or (P?ediatric Daily Occupation* score*)).ti,ab,tm.

Pdos adj10 (autis* or asperg* or asd).ti,ab,tm.

(Pre?school Development* Profile* or (PSDP adj10 (autis* or asperg* or asd)).ti,ab,tm.

(Early Intervention* Development* Profile* or EIDP).ti,ab,tm.

((Early Learning Accomplishment* Profile*) or ((E-LAP or ELAP) adj10 (autis* or asperg* or asd))).ti,ab,tm.

(Learning Accomplishment* Profile?-Diagnostic* or Learning Accomplishment* Profile? Diagnostic* or ((LAP-D or LAPD) adj10 (autis* or asperg* or asd))) .ti,ab,tm.

Or/11-21

Clinical Evaluation of Language* Fundamental?-Revised.ti,ab,tm.

CELF-R.ti,ab,tm.

Comprehensive Assessment? of Spoken Language?.ti,ab,tm.

casl.ti,ab,tm.

Illinois test? of psycholinguistic abilit*.ti,ab,tm.

ITPA.ti,ab,tm.

((Positive adj1 Negative Affect? Scale?) or (Positive adj1 Negative Affect Score?)).ti,ab,tm.

((Positive-Negative Affect? Scale?) or (Positive-Negative Affect? Score?)).ti,ab,tm.

PANAS.ti,ab,tm.

(Satisfaction with Life Scale? or Satisfaction with Life Score?).ti,ab,tm.

Reaction? to Diagnosis Interview?.ti,ab,tm.

(rdi adj10 (autis* or asperg* or asd)).ti,ab,tm.

Brunet Lezine* oculomotor coordination subtest.ti,ab,tm.

(Brunet Lezine* Test* or Brunet-Lezine* Test*).ti,ab,tm.

oculomotor coordination subtest.ti,ab,tm.

Development* Play Assessment?.ti,ab,tm.

((Pre?school Imitation adj1 Praxis Scale?) or (Pre?school Imitation adj1 Praxis Score?)).ti,ab,tm.

(School Liking adj1 Avoidance Questionnaire).ti,ab,tm.

(Teacher? Rating Scale? of School Adjustment? or Teacher? Rating Score? of School Adjustment?).ti,ab,tm.

TRSSA.ti,ab,tm.

(stress-arousal adj1 (checklist or check-list or check list)).ti,ab,tm.

(stress?arousal adj1 (checklist or check-list or check list)).ti,ab,tm.

(stress arousal adj1 (checklist or check-list or check list)).ti,ab,tm.

(Goal attainment scal* or Goal attainment scor*).ti,ab,tm.

(GAS adj10 (autis* or asperg* or asd)).ti,ab,tm.

Parent* Interview* for Autism clinical version.ti,ab,tm.

pia-cv.ti,ab,tm.

Early Years Foundation Stage Profile?.ti,ab,tm.

EYFSP.ti,ab,tm.

Social Cognitive Evaluation Battery.ti,ab,tm.

Sceb.ti,ab,tm.

(Pervasive Development* Disorder? Behavio?r Inventory or pddbi or pdd Behavio?r Inventory).ti,ab,tm.

Clinical Global Impression? Improvement?.ti,ab,tm.

Clinical Global Impression-Improvement.ti,ab,tm.

Cgi-i.ti,ab,tm.

(Autis* treatment Evaluation adj1 (Checklist or check-list or check list)).ti,ab,tm.

Atec.ti,ab,tm.

Or/46-60

10 or 22 or 60

Iterative search: September 2013

Child Behavio?r Questionnaire.ti,ab.

Child Behavio?r Questionnaire.ti,ab,tm.

Child* Behavio?r* Questionnaire short form.ti,ab,tm.

Child* Behavio?r* Questionnaire-Short Form.ti,ab,tm.

(cbqsf or cbq-sf).ti,ab,tm.

cbq.ti,ab,tm.

Maternal Behavio?r* Rat* Scale*.ti,ab,tm.

Maternal Behavio?r* Rat* Score*.ti,ab,tm.

Child* Behavio?r* Rat* Scale*.ti,ab,tm.

Child* Behavio?r* Rat* Score*.ti,ab,tm.

Mbrs or cbrs.ti,ab,tm.

Appendix 7 COSMIN checklist with four-point scale

COSMIN checklist with 4-point scale

Contact
CB Terwee, PhD
VU University Medical Center
Department of Epidemiology and Biostatistics
EMGO Institute for Health and Care Research
1081 BT Amsterdam
The Netherlands
Website: www.cosmin.nl, www.emgo.nl
E-mail: cb.terwee@vumc.nl

Instructions

This version of the COSMIN checklist is recommended for use in systematic reviews of measurement properties. With this version it is possible to calculate overall methodological quality scores per study on a measurement property. A methodological quality score per box is obtained by taking the lowest rating of any item in a box ('worse score counts'). For example, if for a reliability study one item in the box 'Reliability' is scored poor, the methodological quality of that reliability study is rated as poor. The Interpretability box and the Generalizability box are mainly used as data extraction forms. We recommend to use the Interpretability box to extract all information on the interpretability issues described in this box (e.g. norm scores, floor-ceiling effects, minimal important change) of the instruments under study from the included articles. Similar, we recommend to use the Generalizability box to extract data on the characteristics of the study population and sampling procedure. Therefore no scoring system was developed for these boxes.

This scoring system is described in this paper:

Terwee CB, Mokkink LB, Knol DL, Ostelo RWJG, Bouter LM, de Vet HCW. Rating the methodological quality in systematic reviews of studies on measurement properties: a scoring system for the COSMIN checklist. *Quality of Life Research* 2012.[464]

Step 1. Evaluated measurement properties in the article

	Internal consistency	Box A
	Reliability	Box B
	Measurement error	Box C
	Content validity	Box D
	Structural validity	Box E
	Hypotheses testing	Box F
	Cross-cultural validity	Box G
	Criterion validity	Box H
	Responsiveness	Box I

Step 2. Determining if the statistical method used in the article are based on CTT or IRT

Box General requirements for studies that applied Item Response Theory (IRT) models

		excellent	good	fair	poor
1	Was the IRT model used adequately described? e.g. One Parameter Logistic Model (OPLM), Partial Credit Model (PCM), Graded Response Model (GRM)	IRT model adequately described	IRT model not adequately described		
2	Was the computer software package used adequately described? e.g. RUMM2020, WINSTEPS, OPLM, MULTILOG, PARSCALE, BILOG, NLMIXED	Software package adequately described	Software package not adequately described		
3	Was the method of estimation used adequately described? e.g. conditional maximum likelihood (CML), marginal maximum likelihood (MML)	Method of estimation adequately described	Method of estimation not adequately described		
4	Were the assumptions for estimating parameters of the IRT model checked? e.g. unidimensionality, local independence, and item fit (e.g. differential item functioning (DIF))	assumptions of the IRT model checked	assumptions of the IRT model partly checked	assumptions of the IRT model not checked or unknown	

To obtain a total score for the methodological quality of studies that use IRT methods, the ‘worse score counts’ algorithm should be applied to the IRT box in combination with the box of the measurement property that was evaluated in the IRT study. For example, if IRT methods are used to study internal consistency and item 4 in the IRT box is scored fair, while the items in the internal consistency box (box A) are all scored as good or excellent, the methodological quality score for internal consistency will be fair. However, if any of the items in box A is scored poor, the methodological quality score for internal consistency will be poor.

Step 3. Determining if a study meets the standards for good methodological quality

Box A. Internal consistency		excellent	good	fair	poor
1	Does the scale consist of effect indicators, i.e. is it based on a reflective model?				
Design requirements					
2	Was the percentage of missing items given?	Percentage of missing items described	Percentage of missing items NOT described		
3	Was there a description of how missing items were handled?	Described how missing items were handled	Not described but it can be deduced how missing items were handled	Not clear how missing items were handled	
4	Was the sample size included in the internal consistency analysis adequate?	Adequate sample size (≥100)	Good sample size (50-99)	Moderate sample size (30-49)	Small sample size (<30)
5	Was the unidimensionality of the scale checked? i.e. was factor analysis or IRT model applied?	Factor analysis performed in the study population	Authors refer to another study in which factor analysis was performed in a similar study population	Authors refer to another study in which factor analysis was performed, but not in a similar study population	Factor analysis NOT performed and no reference to another study
6	Was the sample size included in the unidimensionality analysis adequate?	7* #items and ≥100	5* #items and ≥100 OR 6-7* #items but <100	5* #items but <100	<5* #items

7	Was an internal consistency statistic calculated for each (unidimensional) (sub)scale separately?	Internal consistency statistic calculated for each subscale separately			Internal consistency statistic NOT calculated for each subscale separately
8	Were there any important flaws in the design or methods of the study?	No other important methodological flaws in the design or execution of the study		Other minor methodological flaws in the design or execution of the study	Other important methodological flaws in the design or execution of the study
Statistical methods					
9	for Classical Test Theory (CTT), continuous scores: Was Cronbach's alpha calculated?	Cronbach's alpha calculated		Only item-total correlations calculated	No Cronbach's alpha and no item-total correlations calculated
10	for CTT, dichotomous scores: Was Cronbach's alpha or KR-20 calculated?	Cronbach's alpha or KR-20 calculated		Only item-total correlations calculated	No Cronbach's alpha or KR-20 and no item-total correlations calculated
11	for IRT: Was a goodness of fit statistic at a global level calculated? E.g. χ^2, reliability coefficient of estimated latent trait value (index of (subject or item) separation)	Goodness of fit statistic at a global level calculated			Goodness of fit statistic at a global level NOT calculated

NB. Item 1 is used to determine whether internal consistency is relevant for the instrument under study. It is not used to rate the quality of the study.

Box B. Reliability: relative measures (including test-retest reliability, inter-rater reliability and intra-rater reliability)

		excellent	good	fair	poor
Design requirements					
1	Was the percentage of missing items given?	Percentage of missing items described	Percentage of missing items NOT described		
2	Was there a description of how missing items were handled?	Described how missing items were handled	Not described but it can be deduced how missing items were handled	Not clear how missing items were handled	
3	Was the sample size included in the analysis adequate?	Adequate sample size (≥100)	Good sample size (50-99)	Moderate sample size (30-49)	Small sample size (<30)
4	Were at least two measurements available?	At least two measurements			Only one measurement
5	Were the administrations independent?	Independent measurements	Assumable that the measurements were independent	Doubtful whether the measurements were independent	measurements NOT independent
6	Was the time interval stated?	Time interval stated		Time interval NOT stated	
7	Were patients stable in the interim period on the construct to be measured?	Patients were stable (evidence provided)	Assumable that patients were stable	Unclear if patients were stable	Patients were NOT stable
8	Was the time interval appropriate?	Time interval appropriate		Doubtful whether time interval was appropriate	Time interval NOT appropriate
9	Were the test conditions similar for both measurements? e.g. type of administration, environment, instructions	Test conditions were similar (evidence provided)	Assumable that test conditions were similar	Unclear if test conditions were similar	Test conditions were NOT similar

10	Were there any important flaws in the design or methods of the study?	No other important methodological flaws in the design or execution of the study		Other minor methodological flaws in the design or execution of the study	Other important methodological flaws in the design or execution of the study
Statistical methods					
11	for continuous scores: Was an intraclass correlation coefficient (ICC) calculated?	ICC calculated and model or formula of the ICC is described	ICC calculated but model or formula of the ICC not described or not optimal. Pearson or Spearman correlation coefficient calculated with evidence provided that no systematic change has occurred	Pearson or Spearman correlation coefficient calculated WITHOUT evidence provided that no systematic change has occurred or WITH evidence that systematic change has occurred	No ICC or Pearson or Spearman correlations calculated
12	for dichotomous/nominal/ordinal scores: Was kappa calculated?	Kappa calculated			Only percentage agreement calculated
13	for ordinal scores: Was a weighted kappa calculated?	Weighted Kappa calculated		Unweighted Kappa calculated	Only percentage agreement calculated
14	for ordinal scores: Was the weighting scheme described? e.g. linear, quadratic	Weighting scheme described	Weighting scheme NOT described		

Box C. Measurement error: absolute measures

		excellent	good	fair	poor
Design requirements					
1	Was the percentage of missing items given?	Percentage of missing items described	Percentage of missing items NOT described		
2	Was there a description of how missing items were handled?	Described how missing items were handled	Not described but it can be deduced how missing items were handled	Not clear how missing items were handled	
3	Was the sample size included in the analysis adequate?	Adequate sample size (≥100)	Good sample size (50-99)	Moderate sample size (30-49)	Small sample size (<30)
4	Were at least two measurements available?	At least two measurements			Only one measurement
5	Were the administrations independent?	Independent measurements	Assumable that the measurements were independent	Doubtful whether the measurements were independent	measurements NOT independent
6	Was the time interval stated?	Time interval stated		Time interval NOT stated	
7	Were patients stable in the interim period on the construct to be measured?	Patients were stable (evidence provided)	Assumable that patients were stable	Unclear if patients were stable	Patients were NOT stable
8	Was the time interval appropriate?	Time interval appropriate		Doubtful whether time interval was appropriate	Time interval NOT appropriate
9	Were the test conditions similar for both measurements? e.g. type of administration, environment, instructions	Test conditions were similar (evidence provided)	Assumable that test conditions were similar	Unclear if test conditions were similar	Test conditions were NOT similar

10 Were there any important flaws in the design or methods of the study?	No other important methodological flaws in the design or execution of the study		Other minor methodological flaws in the design or execution of the study	Other important methodological flaws in the design or execution of the study
Statistical methods				
11 for CTT: Was the Standard Error of Measurement (SEM), Smallest Detectable Change (SDC) or Limits of Agreement (LoA) calculated?	SEM, SDC, or LoA calculated	Possible to calculate LoA from the data presented		SEM calculated based on Cronbach's alpha, or on SD from another population

Box D. Content validity (including face validity)				
	excellent	**good**	**fair**	**poor**
General requirements				
1 Was there an assessment of whether all items refer to relevant aspects of the construct to be measured?	Assessed if all items refer to relevant aspects of the construct to be measured		Aspects of the construct to be measured poorly described AND this was not taken into consideration	NOT assessed if all items refer to relevant aspects of the construct to be measured
2 Was there an assessment of whether all items are relevant for the study population? (e.g. age, gender, disease characteristics, country, setting)	Assessed if all items are relevant for the study population in adequate sample size (≥10)	Assessed if all items are relevant for the study population in moderate sample size (5-9)	Assessed if all items are relevant for the study population in small sample size (<5)	NOT assessed if all items are relevant for the study population OR target population not involved

3	Was there an assessment of whether all items are relevant for the purpose of the measurement instrument? (discriminative, evaluative, and/or predictive)	Assessed if all items are relevant for the purpose of the application	Purpose of the instrument was not described but assumed	NOT assessed if all items are relevant for the purpose of the application	
4	Was there an assessment of whether all items together comprehensively reflect the construct to be measured?	Assessed if all items together comprehensively reflect the construct to be measured		No theoretical foundation of the construct and this was not taken into consideration	NOT assessed if all items together comprehen-sively reflect the construct to be measured
5	Were there any important flaws in the design or methods of the study?	No other important methodological flaws in the design or execution of the study		Other minor methodological flaws in the design or execution of the study	Other important methodological flaws in the design or execution of the study

Box E. Structural validity

		excellent	good	fair	poor
1	Does the scale consist of effect indicators, i.e. is it based on a reflective model?				
	Design requirements				
2	Was the percentage of missing items given?	Percentage of missing items described	Percentage of missing items NOT described		
3	Was there a description of how missing items were handled?	Described how missing items were handled	Not described but it can be deduced how missing items were handled	Not clear how missing items were handled	
4	Was the sample size included in the analysis adequate?	7* #items and ≥100	5* #items and ≥100 OR 5-7* #items but <100	5* #items but <100	<5* #items
5	Were there any important flaws in the design or methods of the study?	No other important methodological flaws in the design or execution of the study		Other minor methodological flaws in the design or execution of the study (e.g. rotation method not described)	Other important methodological flaws in the design or execution of the study (e.g. inappropriate rotation method)

Statistical methods					
6	for CTT: Was exploratory or confirmatory factor analysis performed?	Exploratory or confirmatory factor analysis performed and type of factor analysis appropriate in view of existing information	Exploratory factor analysis performed while confirmatory would have been more appropriate		No exploratory or confirmatory factor analysis performed
7	for IRT: Were IRT tests for determining the (uni-) dimensionality of the items performed?	IRT test for determining (uni)dimension-ality performed			IRT test for determining (uni)dimension-ality NOT performed

Box F. Hypotheses testing

		excellent	good	fair	Poor
Design requirements					
1	Was the percentage of missing items given?	Percentage of missing items described	Percentage of missing items NOT described		
2	Was there a description of how missing items were handled?	Described how missing items were handled	Not described but it can be deduced how missing items were handled	Not clear how missing items were handled	
3	Was the sample size included in the analysis adequate?	Adequate sample size (≥100 per analysis)	Good sample size (50-99 per analysis)	Moderate sample size (30-49 per analysis)	Small sample size (<30 per analysis)

4	Were hypotheses regarding correlations or mean differences formulated a priori (i.e. before data collection)?	Multiple hypotheses formulated a priori	Minimal number of hypotheses formulate a priori	Hypotheses vague or not formulated but possible to deduce what was expected	Unclear what was expected
5	Was the expected *direction* of correlations or mean differences included in the hypotheses?	Expected direction of the correlations or differences stated	Expected direction of the correlations or differences NOT stated		
6	Was the expected absolute or relative *magnitude* of correlations or mean differences included in the hypotheses?	Expected magnitude of the correlations or differences stated	Expected magnitude of the correlations or differences NOT stated		
7	for convergent validity: Was an adequate description provided of the comparator instrument(s)?	Adequate description of the constructs measured by the comparator instrument(s)	Adequate description of most of the constructs measured by the comparator instrument(s)	Poor description of the constructs measured by the comparator instrument(s)	NO description of the constructs measured by the comparator instrument(s)
8	for convergent validity: Were the measurement properties of the comparator instrument(s) adequately described?	Adequate measurement properties of the comparator instrument(s) in a population similar to the study population	Adequate measurement properties of the comparator instrument(s) but not sure if these apply to the study population	Some information on measurement properties (or a reference to a study on measurement properties) of the comparator instrument(s) in any study population	No information on the measurement properties of the comparator instrument(s)

9 Were there any important flaws in the design or methods of the study?	No other important methodological flaws in the design or execution of the study		Other minor methodological flaws in the design or execution of the study (e.g. only data presented on a comparison with an instrument that measures another construct)	Other important methodological flaws in the design or execution of the study
Statistical methods				
10 Were design and statistical methods adequate for the hypotheses to be tested?	Statistical methods applied appropriate	Assumable that statistical methods were appropriate, e.g. Pearson correlations applied, but distribution of scores or mean (SD) not presented	Statistical methods applied NOT optimal	Statistical methods applied NOT appropriate

Box G. Cross-cultural validity				
	excellent	**good**	**fair**	**poor**
Design requirements				
1 Was the percentage of missing items given?	Percentage of missing items described	Percentage of missing items NOT described		
2 Was there a description of how missing items were handled?	Described how missing items were handled	Not described but it can be deduced how missing items were handled	Not clear how missing items were handled	

3	Was the sample size included in the analysis adequate?	CTT: 7* #items and ≥100 IRT: ≥200 per group	CTT: 5* #items and ≥100 OR 5-7* #items but <100 IRT: ≥200 in 1 group and 100-199 in 1 group	CTT: 5* #items but <100 IRT: 100-199 per group	CTT: <5* #items IRT: (<100 in 1 or both groups
4	Were both the original language in which the HR-PRO instrument was developed, and the language in which the HR-PRO instrument was translated described?	Both source language and target language described			Source language NOT known
5	Was the expertise of the people involved in the translation process adequately described? e.g. expertise in the disease(s) involved, expertise in the construct to be measured, expertise in both languages	Expertise of the translators described with respect to disease, construct, and language	Expertise of the translators with respect to disease or construct poor or not described	Expertise of the translators with respect to language not described	
6	Did the translators work independently from each other?	Translators worked independent	Assumable that the translators worked independent	Unclear whether translators worked independent	Translators worked NOT independent
7	Were items translated forward and backward?	Multiple forward and multiple backward translations	Multiple forward translations but one backward translation	One forward and one backward translation	Only a forward translation
8	Was there an adequate description of how differences between the original and translated versions were resolved?	Adequate description of how differences between translators were resolved	Poorly or NOT described how differences between translators were resolved		
9	Was the translation reviewed by a committee (e.g. original developers)?	Translation reviewed by a committee (involving other people than the translators, e.g. the original developers)	Translation NOT reviewed by (such) a committee		

10	Was the HR-PRO instrument pre-tested (e.g. cognitive interviews) to check interpretation, cultural relevance of the translation, and ease of comprehension?	Translated instrument pre-tested in the target population	Translated instrument pre-tested, but unclear if this was done in the target population	Translated instrument pre-tested, but NOT in the target population	Translated instrument NOT pre-tested
11	Was the sample used in the pre-test adequately described?	Sample used in the pre-test adequately described		Sample used in the pre-test NOT (adequately) described	
12	Were the samples similar for all characteristics except language and/or cultural background?	Shown that samples were similar for all characteristics except language /culture	Stated (but not shown) that samples were similar for all characteristics except language /culture	Unclear whether samples were similar for all characteristics except language /culture	Samples were NOT similar for all characteristics except language /culture
13	Were there any important flaws in the design or methods of the study?	No other important methodological flaws in the design or execution of the study		Other minor methodological flaws in the design or execution of the study	Other important methodological flaws in the design or execution of the study

Statistical methods					
14	for CTT: Was confirmatory factor analysis performed?	Multiple-group confirmatory factor analysis performed			Multiple-group confirmatory factor analysis NOT performed
15	for IRT: Was differential item function (DIF) between language groups assessed?	DIF between language groups assessed			DIF between language groups NOT assessed

Box H. Criterion validity

		excellent	good	fair	poor
Design requirements					
1	Was the percentage of missing items given?	Percentage of missing items described	Percentage of missing items NOT described		
2	Was there a description of how missing items were handled?	Described how missing items were handled	Not described but it can be deduced how missing items were handled	Not clear how missing items were handled	
3	Was the sample size included in the analysis adequate?	Adequate sample size (≥100)	Good sample size (50-99)	Moderate sample size (30-49)	Small sample size (<30)
4	Can the criterion used or employed be considered as a reasonable ‘gold standard’?	Criterion used can be considered an adequate ‘gold standard’ (evidence provided)	No evidence provided, but assumable that the criterion used can be considered an adequate ‘gold standard’	Unclear whether the criterion used can be considered an adequate ‘gold standard’	Criterion used can NOT be considered an adequate ‘gold standard’

5	Were there any important flaws in the design or methods of the study?	No other important methodological flaws in the design or execution of the study		Other minor methodological flaws in the design or execution of the study	Other important methodological flaws in the design or execution of the study
Statistical methods					
6	for continuous scores: Were correlations, or the area under the receiver operating curve calculated?	Correlations or AUC calculated			Correlations or AUC NOT calculated
7	for dichotomous scores: Were sensitivity and specificity determined?	Sensitivity and specificity calculated			Sensitivity and specificity NOT calculated

Box I. Responsiveness

		excellent	good	fair	poor
Design requirements					
1	Was the percentage of missing items given?	Percentage of missing items described	Percentage of missing items NOT described		
2	Was there a description of how missing items were handled?	Described how missing items were handled	Not described but it can be deduced how missing items were handled	Not clear how missing items were handled	
3	Was the sample size included in the analysis adequate?	Adequate sample size (≥100)	Good sample size (50-99)	Moderate sample size (30-49)	Small sample size (<30)
4	Was a longitudinal design with at least two measurement used?	Longitudinal design used			No longitudinal design used
5	Was the time interval stated?	Time interval adequately described			Time interval NOT described

6	If anything occurred in the interim period (e.g. intervention, other relevant events), was it adequately described?	Anything that occurred during the interim period (e.g. treatment) adequately described	Assumable what occurred during the interim period	Unclear or NOT described what occurred during the interim period	
7	Was a proportion of the patients changed (i.e. improvement or deterioration)?	Part of the patients were changed (evidence provided)	NO evidence provided, but assumable that part of the patients were changed	Unclear if part of the patients were changed	Patients were NOT changed
Design requirements for hypotheses testing					
	For constructs for which a gold standard was not available:				
8	Were hypotheses about changes in scores formulated a priori (i.e. before data collection)?	Hypotheses formulated a priori		Hypotheses vague or not formulated but possible to deduce what was expected	Unclear what was expected
9	Was the expected *direction* of correlations or mean differences of the change scores of HR-PRO instruments included in these hypotheses?	Expected direction of the correlations or differences stated	Expected direction of the correlations or differences NOT stated		
10	Were the expected absolute or relative *magnitude* of correlations or mean differences of the change scores of HR-PRO instruments included in these hypotheses?	Expected magnitude of the correlations or differences stated	Expected magnitude of the correlations or differences NOT stated		
11	Was an adequate description provided of the comparator instrument(s)?	Adequate description of the constructs measured by the comparator instrument(s)		Poor description of the constructs measured by the comparator instrument(s)	NO description of the constructs measured by the comparator instrument(s)

12	Were the measurement properties of the comparator instrument(s) adequately described?	Adequate measurement properties of the comparator instrument(s) in a population similar to the study population	Adequate measurement properties of the comparator instrument(s) but not sure if these apply to the study population	Some information on measurement properties (or a reference to a study on measurement properties) of the comparator instrument(s) in any study population	NO information on the measurement properties of the comparator instrument(s)
13	Were there any important flaws in the design or methods of the study?	No other important methodological flaws in the design or execution of the study		Other minor methodological flaws in the design or execution of the study (e.g. only data presented on a comparison with an instrument that measures another construct)	Other important methodological flaws in the design or execution of the study
Statistical methods					
14	Were design and statistical methods adequate for the hypotheses to be tested?	Statistical methods applied appropriate		Statistical methods applied NOT optimal	Statistical methods applied NOT appropriate

Design requirement for comparison to a gold standard					
	For constructs for which a gold standard was available:				
15	Can the criterion for change be considered as a reasonable gold standard?	Criterion used can be considered an adequate 'gold standard' (evidence provided)	No evidence provided, but assumable that the criterion used can be considered an adequate 'gold standard'	Unclear whether the criterion used can be considered an adequate 'gold standard'	Criterion used can NOT be considered an adequate 'gold standard'
16	Were there any important flaws in the design or methods of the study?	No other important methodological flaws in the design or execution of the study		Other minor methodological flaws in the design or execution of the study	Other important methodological flaws in the design or execution of the study
Statistical methods					
17	for continuous scores: Were correlations between change scores, or the area under the Receiver Operator Curve (ROC) curve calculated?	Correlations or Area under the ROC Curve (AUC) calculated			Correlations or AUC NOT calculated
18	for dichotomous scales: Were sensitivity and specificity (changed versus not changed) determined?	Sensitivity and specificity calculated			Sensitivity and specificity NOT calculated

Interpretability

We recommend to use the Interpretability box to extract all information on the interpretability issues described in this box of the instruments under study from the included articles.

Box Interpretability	
Percentage of missing items	
Description of how missing items were handled	
Distribution of the (total) scores	
Percentage of the respondents who had the lowest possible (total) score	
Percentage of the respondents who had the highest possible (total) score	
Scores and change scores (i.e. means and SD) for relevant (sub) groups, e.g. for normative groups, subgroups of patients, or the general population	
Minimal Important Change (MIC) or Minimal Important Difference (MID)	

Generalizability

We recommend to use the Generalizability box to extract data on the characteristics of the study populations and sampling procedures of the included studies.

Box Generalisability	
Median or mean age (with standard deviation or range)	
Distribution of sex	
Important disease characteristics (e.g. severity, status, duration) and description of treatment	
Setting(s) in which the study was conducted (e.g. general population, primary care or hospital/rehabilitation care)	
Countries in which the study was conducted	
Language in which the HR-PRO instrument was evaluated	
Method used to select patients (e.g. convenience, consecutive, or random)	
Percentage of missing responses (response rate)	

Appendix 8 Tables of papers and data extracted (see *Chapter 4*)

Symptom severity (change in diagnostic category, autism severity, diagnostic scores used as measures of outcome)											
			Reliability				Hypothesis testing			Responsiveness	
Measurement tool	Report ID	Internal consistency	Test–retest	Inter-rater	Content validity	Structural validity	Convergent/ divergent	Stability	Criterion validity	Stability	Change
Autism Behavior Checklist	Miranda-Linne 2002[62]	Good+				Fair+					
	Sponheim 1996[60]			Poor?							
	Sturmey 1992[61]	Poor?									
Autism Diagnostic Interview-Revised	Chawarska 2007[70]								Fair+		
	De Bildt 2013[139]	Fair+									
	Frazier 2008[67]			Fair+		Good–					
	Kamp-Becker 2009[72]					Poor–					
	Lecavalier 2006[146]	Good+				Good–	Good–				
	Lord 1994[63]	Poor+		Poor+	Excellent+				Good+		
	Lord 2006[65]			Fair+						Fair+	
	Moss 2008[71]			Poor+						Fair+	
	Snow 2009[68]	Fair+				Fair+					
	Tadevosyan-Leyfer 2003[66]				Good?	Poor?	Good–				
	Tsuchiya 2013[69]			Good+				Good+			
	Ward-King 2010[140]			Poor+							
Autism Diagnostic Observation Schedule-Calibrated Severity Score	De Bildt 2011[78]							Fair+			
	Gotham 2009[77]					Good+					
	Shumway 2012[79]							Good+		Fair+	

Symptom severity (change in diagnostic category, autism severity, diagnostic scores used as measures of outcome)											
			Reliability				Hypothesis testing			Responsiveness	
Measurement tool	Report ID	Internal consistency	Test–retest	Inter-rater	Content validity	Structural validity	Convergent/ divergent	Stability	Criterion validity	Stability	Change
Autism Diagnostic Observation Schedule-Generic	Chawarska 2007[70]								Fair+/–	Fair+	
	Ben Itzchak 2009[75]									Poor+	
	Grey 2008[74]								Good+		
	Kamp-Becker 2009[72]			Poor+		Good+					
	Lord 2000 (module 1)[50]	Poor+		Poor+		Poor+					
	Lord 2000 (module 2)[50]	Poor+		Poor+		Poor+					
	Lord 2000[50]	Poor+		Poor+		Poor+					
	Lord 2006[65]			Fair+						Fair+	
	Norris 2012 (module 1)[73]					Excellent+					
	Norris 2012 (module 3)[73]					Excellent–					
Autism Diagnostic Observation Schedule-Toddler Module	Luyster 2009[76]	Fair+/–	Fair+/–	Poor+	Fair+						
Autism Observation Scale for Infants	Bryson 2008[81]		Poor?	Poor+							
	Georgiades 2013[82]							Good+			
Baby and Infant Screen for Children with aUtIsm Traits-Part 1 (BISCUIT-Part 1)	Matson 2009[83]	Poor+									
	Matson 2010[84]	Good+				Good–		Good+			
	Matson 2011[85]						Good+				
Behavioral Summarized Evaluation	Barthelemy 1990[86]			Fair+	Excellent+	Poor+					
	Oneal 2006[88]	Poor+				Poor–	Fair+				
Behavioral Summarized Evaluation Scale-Revised	Barthelemy 1997[87]			Poor+		Fair+		Fair+	Poor?		
	Roux 1995[89]					Excellent+					

Symptom severity (change in diagnostic category, autism severity, diagnostic scores used as measures of outcome)											
		Reliability					Hypothesis testing			Responsiveness	
Measurement tool	Report ID	Internal consistency	Test–retest	Inter-rater	Content validity	Structural validity	Convergent/ divergent	Stability	Criterion validity	Stability	Change
Childhood Autism Rating Scale	Darrou 2010[95]			Good+							
	Magyar 2007[94]	Excellent+				Excellent–					
	Nordin 1998[465]	Poor+		Good–							
	Russell 2010[93]	Excellent+		Excellent+		Excellent+					
	Schopler 1980[244]	Poor+		Good–							
	Sevin 1991[109]			Poor–							
	Sponheim 1996[60]			Poor?							
	Stella 1999[96]					Good+	Good–				
	Sturmey 1992[61]	Poor+									
	Tachimori 2003[466]	Poor+									
Gilliam Autism Rating Scale	Lecavalier 2005[98]	Good+		Good–		Good–					
	South 2002[97]							Fair–			
Gilliam Autism Rating Scale-Second Edition	Pandolfi 2010[99]	Good+					Fair–				
Infant Behavioral Summarized Evaluation	Adrien 1992[90]			Fair+		Poor+					
Modified Checklist for Autism in Toddlers	Inada 2011[103]			Poor+					Poor–		
	Robins 2001[101]	Poor+									
	Snow 2008[102]	Poor+							Fair+		
Parent Observation of Early Markers Scale	Feldman 2012[104]	Good+	Poor+				Good–				
Pervasive Developmental Disorders Behavior Inventory	Cohen 2003[122]	Good+		Good+/–	Excellent+	Good+					
	Cohen 2003[123]								Fair–		

Symptom severity (change in diagnostic category, autism severity, diagnostic scores used as measures of outcome)											
			Reliability				Hypothesis testing			Responsiveness	
Measurement tool	Report ID	Internal consistency	Test–retest	Inter-rater	Content validity	Structural validity	Convergent/divergent	Stability	Criterion validity	Stability	Change
Pervasive Developmental Disorders Rating Scale	Williams 2002[107]	Good+	Fair+								
	Williams 2005[42]	Poor+				Poor+					
Real Life Rating Scale	Sevin 1991[109]			Poor–							
	Sturmey 1992[61]	Poor–									
Social Communication Questionnaire	Charman 2004[112]									Good+	
	Magyar 2012[111]	Good+				Good+			Good+		
	Snow 2008[102]	Poor?							Fair+		
Social Responsiveness Scale	Pine 2006[117]		Fair–	Fair–					Poor–		
	Bolte 2008[115]	Good+	Fair+	Fair+		Good–	Fair+		Good–		
	Constantino 2004[114]					Good–					
	Constantino 2009[118]			Fair–		Poor?					
	Duku 2013[116]	Good+			Poor–	Excellent–	Good+				
Pre-Verbal Communication Schedule	N/A										
Social Communication Behaviour Codes	N/A										

N/A, not available.
Dark green, excellent; pale green, good; dark blue, fair; pale blue, poor.
?, indeterminate; –, negative; +, positive.

Social awareness (joint attention skills, imitation, social attention)											
			Reliability				Hypothesis testing			Responsiveness	
Measurement tool	Report ID	Internal consistency	Test–retest	Inter-rater	Content validity	Structural validity	Convergent/ divergent	Known groups	Criterion validity	Stability	Change
Communication and Symbolic Behavior Scales-Developmental Profile-Behavior Sample	Wetherby 2004[126]			Poor?							
Early Social Communication Scales Live	Luyster 2008[129]			Poor?							
Imitation Battery	Luyster 2008[129]			Poor?							
	Young 2011[131]			Good+				Good+			
Imitation Disorders Evaluation scale	Malvy 1999[132]			Poor?		Poor+					
Motor Imitation Scale	Ingersoll 2011[134]							Poor+			
Preschool Imitation and Praxis Scale	Vanvuchelen 2011[135]	Excellent+				Excellent+	Poor+				
	Vanvuchelen 2011[136]			Fair+							
Social Communication Assessment for Toddlers with Autism	Drew 2007[137]			Poor+			Poor+	Poor+		Poor+	

Dark green, excellent; pale green, good; dark blue, fair; pale blue, poor.
?, indeteminate; +, positive.

Restricted, repetitive behaviour (repetitive, stereotyped movements; repetitive use of objects; attention to detail; insistence on sameness)											
			Reliability				Hypothesis testing			Responsiveness	
Measurement tool	Report ID	Internal consistency	Test–retest	Inter-rater	Content validity	Structural validity	Convergent/ divergent	Known groups	Criterion validity	Stability	Change
Autism Diagnostic Interview-Revised	Bishop 2006[143]					Good?	Fair+				
	Cuccaro 2003[138]	Excellent–				Excellent+	Fair+				
	De Bildt 2013[139]	Good–									
	Frazier 2008[67]			Fair+		Good–					
	Grey 2008[74]								Good+		
	Kamp-Becker 2009[72]					Poor–	Fair+				
	Lam 2008[142]					Fair+	Fair+				
	Lecavalier 2006[64]	Good–				Good–	Good+				
	Lord 1994[63]	Poor–	Poor+	Poor+	Excellent+				Good+		
	Lord 2006[65]			Fair+							Fair+
	Mooney 2009[148]					Excellent–					
	Moss 2008[71]			Poor+						Fair+	
	Richler 2010[144]					Good?					
	Shao 2003[145]					Good?					
	Smith 2009[141]					Excellent+					
	Snow 2009[68]	Excellent–				Excellent+	Fair+				
	Szatmari 2006[147]					Good–					
	Tadevosyan-Leyfer 2003[66]				Good?	Poor–	Good+				
	Tsuchiya 2013[69]			Good+			Good+				
	Ward-King 2010[140]		Poor+								

Restricted, repetitive behaviour (repetitive, stereotyped movements; repetitive use of objects; attention to detail; insistence on sameness)											
			Reliability				Hypothesis testing			Responsiveness	
Measurement tool	Report ID	Internal consistency	Test–retest	Inter-rater	Content validity	Structural validity	Convergent/divergent	Known groups	Criterion validity	Stability	Change
Autism Diagnostic Observation Schedule-Generic	Chawarska 2007[70]								Fair+	Fair+	
	Grey 2008 (modules 1 and 2)[74]								Good+		
	Ben Itzchak 2009[75]										Fair+
	Kamp-Becker 2009[72]			Poor?		Good+					
	Lord 2000 (modules 1–3)[50]	Poor–	Poor–			Poor+					
	Lord 2006[65]			Fair–							Fair+
	Norris 2012 (modules 1 and 3)[73]					Excellent+ (modules 1 and 3)					
Autism Diagnostic Observation Schedule-Toddler Module	Luyster 2009[76]	Fair–	Fair?	Poor+	Fair+						
Repetitive Behavior Scale-Revised	Lam 2007[151]	Excellent+	Poor–			Excellent–			Fair+		
	Mirenda 2010[152]	Excellent+				Excellent–			Fair+		

Dark green, excellent; pale green, good; dark blue, fair; pale blue, poor.
?, indeteminate; –, negative; +, positive.

Sensory processing (hypersensitivity or hyposensitivity)											
			Reliability				Hypothesis testing			Responsiveness	
Measurement tool	Report ID	Internal consistency	Test–retest	Inter-rater	Content validity	Structural validity	Convergent/divergent	Known groups	Criterion validity	Stability	Change
Sense and Self-Regulation Checklist	Silva 2012[153]	Poor+	Fair–				Fair+	Fair+			
Sensory Profile	Brown 2008[155]							Fair+			
Short Sensory Profile	O'Brien 2009[156]	Poor+						Fair+			
	Wiggins 2009[157]						Fair+	Fair+			
Infant/Toddler Sensory Profile	N/A										

N/A, not available.
Dark blue, fair; pale blue, poor.
–, negative; +, positive.

Language (expressive language, receptive language, gestures)											
			Reliability				Hypothesis testing			Responsiveness	
Measurement tool	Report ID	Internal consistency	Test–retest	Inter-rater	Content validity	Structural validity	Convergent/divergent	Known groups	Criterion validity	Stability	Change
Comprehensive Assessment of Spoken Language	Reichow 2008[159]								Fair–		
MacArthur–Bates Communicative Development Inventories	Bruckner 2007[162]				Excellent+			Fair+			
	Luyster 2008[129]							Fair+			
Mullen Scales of Early Learning	Burns 2013[164]							Good+			
Preschool Language Scale-Fourth Edition	Volden 2011[166]						Good+				
Vineland Adaptive Behavior Scales	Harris 1995[168]										Poor+
	Paul 2004[169]							Fair+			
Vineland Adaptive Behavior Scales-Classroom version	Wells 2009[170]						Fair+				
Vineland Adaptive Behavior Scales-Screener version	Charman 2004[112]										Poor+
Autism Screening Instrument for Educational Planning (ASIEP and ASIEP-2)	N/A										
Battelle Developmental Inventory	N/A										
British Picture Vocabulary Scale	N/A										
Clinical Evaluation of Language Fundamentals-Revised	N/A										
Expressive One-Word Picture Vocabulary Test	N/A										
Illinois Test of Psycholinguistic Abilities	N/A										
Pragmatics Profile	N/A										
Reynell Developmental Language Scales	N/A										
Sequenced Inventory of Communication	N/A										
Test for Auditory Comprehension of Language	N/A										
Test of Language Development	N/A										

N/A, not available.
Dark green, excellent; pale green, good; dark blue, fair; pale blue, poor.
–, negative; +, positive.

Cognitive ability (IQ/developmental quotient, non-verbal ability, verbal ability/reasoning)											
			Reliability				Hypothesis testing			Responsiveness	
Measurement tool	Report ID	Internal consistency	Test–retest	Inter-rater	Content validity	Structural validity	Convergent/ divergent	Known groups	Criterion validity	Stability	Change
Leiter International Performance Scale-Revised	Grondhuis 2013[175]							Fair–	Fair–		
	Scattone 2012[173]						Fair+				
	Tsatsanis 2003[174]						Poor+				
Mullen Scales of Early Learning-Early Learning Composite	Georgiades 2013[82]							Good+			
Mullen Scales of Early Learning	Bishop 2011[176]								Good+		
	Burns 2013[164]							Good–			
Stanford–Binet Intelligence Scales-Fifth Edition	Grondhuis 2013[175]							Fair+	Fair–		
Wechsler Preschool and Primary Scale of Intelligence-Revised	Yang 2011[180]										Fair–
Battelle Developmental Inventory	N/A										
Bayley Scales of Infant Development	N/A										
Behaviour Rating Inventory of Executive Function (BRIEF)-Preschool Version	N/A										
British Ability Scales	N/A										
Cattell Infant Intelligence	N/A										
Developmental Profile	N/A										
Griffiths Mental Developmental Scales	N/A										
Leiter Performance Scales-Arthur adaptation	N/A										
McCarthy Scales of Children's Abilities	N/A										
Merrill–Palmer Scale of Mental Tests	N/A										
Snijders Oomen Non-verbal Intelligence Test	N/A										
Wechsler Intelligence Scale for Children-Revised	N/A										

N/A, not available.
Pale green, good; dark blue, fair; pale blue, poor.
–, negative; +, positive.

Attention (distractibility, impulsivity, hyperactivity)												
			Reliability				Hypothesis testing			Responsiveness	
Measurement tool	Report ID	Internal consistency	Test–retest	Inter-rater	Content validity	Structural validity	Convergent/divergent	Known groups	Criterion validity	Stability	Change
Behavior Assessment System for Children-Parent Rating Scales, Second Edition	Hass 2010[182]	Poor+									
	Mahan 2011[183]							Good+			
Child Behavior Checklist 1.5–5	Pandolfi 2009[185]	Good–				Good+					
Child Behavior Checklist 6–18	Pandolfi 2012[186]					Poor+					
Child Behavior Scale	N/A										
Conners Rating Scales-Revised	N/A										

N/A, not available.
Pale green, good; pale blue, poor.
–, negative; +, positive.

Emotional regulation (irritability, distress, anxiety)											
			Reliability				Hypothesis testing			Responsiveness	
Measurement tool	Report ID	Internal consistency	Test–retest	Inter-rater	Content validity	Structural validity	Convergent/ divergent	Known groups	Criterion validity	Stability	Change
Baby and Infant Screen for Children with aUtIsm Traits-Part 2	Matson 2009[188]	Good+		Fair+				Fair+	Good+		
	Matson 2009[83]	Poor+									
	Matson 2011[187]	Excellent+				Poor–		Fair+			
Behavior Assessment System for Children-Second Edition	Hass 2010[182]	Fair+						Fair+			
	Mahan 2011[183]							Good–			
Brief Infant-Toddler Social and Emotional Assessment	Karabekiroglu 2010[190]	Poor–	Fair+	Fair–			Fair+	Fair+			
	Briggs-Gowan 2004[189]	Poor–		Fair–				Good+			
Child Behavior Checklist 1.5–5	Pandolfi 2009[185]	Good+				Good+					
Child Behavior Checklist 6–18	Pandolfi 2012[186]	Good+				Good+			Good+		
Children's Global Assessment Scale	Lundh 2013[193]										Fair+
Infant–Toddler Social–Emotional Assessment	Georgiades 2013[82]							Good+			
	Visser 2010[195]	Poor?		Good+				Good+			
Conners Rating Scales and Revised	N/A										
Developmental Behaviour Checklist	N/A										
Emotion Regulation Checklist	N/A										
Toddler Behaviour Assessment Questionnaire	N/A										

N/A, not available.
Dark green, excellent; pale green, good; dark blue, fair; pale blue, poor.
?, indeteminate; –, negative; +, positive.

Physical skills (poor co-ordination/gross motor skills, fine motor skills)											
			Reliability				Hypothesis testing			Responsiveness	
Measurement tool	Report ID	Internal consistency	Test–retest	Inter-rater	Content validity	Structural validity	Convergent/divergent	Known groups	Criterion validity	Stability	Change
Mullen Scales of Early Learning	Burns 2013[164]							Good+			
Vineland Adaptive Behavior Scales	Harris 1995[168]										Poor+
Vineland Adaptive Behavior Scales-Screener	Charman 2004[112]										Poor+
Beery Visual-Motor Integration Test	N/A										
Brunet-Lezine's oculomotor co-ordination subtest	N/A										
Functional Independence Measure for children (WeeFIM)	N/A										
Infant Motor Maturity and Atypicality Coding Scales	N/A										
Peabody Developmental Motor Scales	N/A										

N/A, not available.
Pale green, good; pale blue, poor.
+, positive.

Social communication (frequency/quality of initiations, pragmatics)											
		Reliability					Hypothesis testing			Responsiveness	
Measurement tool	Report ID	Internal consistency	Test–retest	Inter-rater	Content validity	Structural validity	Convergent/divergent	Known groups	Criterion validity	Stability	Change
Autism Diagnostic Interview-Revised	Chawarska 2007[70]								Fair–		
	De Bildt 2013[139]	Good+									
	Frazier 2008[67]			Fair+		Good–					
	Kamp-Becker 2009[72]					Poor–					
	Lecavalier 2006[64]	Good+				Good–	Good–				
	Lord 1994[63]	Poor–		Poor+	Excellent+			Good+			
	Lord 2006[65]			Fair+							Fair+
	Moss 2008[71]			Poor+							Fair+
	Robertson 1999[196]			Poor+		Poor+		Good+			
	Snow 2009[68]	Fair+						Fair–			
	Tadevosyan-Leyfer 2003[66]				Good+	Poor–	Good–				
	Tanguay 1998[197]					Poor+					
	Tsuchiya 2013[69]			Good+				Good+			
	Ward-King 2010[140]			Poor+							
Autism Diagnostic Observation Schedule-Generic	Chawarska 2007[70]								Poor+		Poor–
	Ben Itzchak 2009[75]										Poor+
	Kamp-Becker 2009[72]			Poor+		Good+					
	Lord 2000 (module 1)[50]	Poor+		Poor+		Poor+					
	Lord 2000 (module 2)[50]	Poor+		Poor+		Poor+					
	Lord 2000 (module 3)[50]	Poor+		Poor–		Poor+					
	Lord 2006 (ADOS)[65]			Fair–							Fair+
	Norris 2012 (module 1)[73]					Excellent–					
	Norris 2012 (module 3)[73]					Excellent–					

Social communication (frequency/quality of initiations, pragmatics)											
		Reliability					Hypothesis testing			Responsiveness	
Measurement tool	Report ID	Internal consistency	Test–retest	Inter-rater	Content validity	Structural validity	Convergent/divergent	Known groups	Criterion validity	Stability	Change
Autism Diagnostic Observation Schedule-Toddler Module	Luyster 2009[76]	Fair+	Fair+	Poor+	Fair+						
Early Social Communication Scales Live	Luyster 2008[129]			Poor+							
Social Communication Assessment for Toddlers with Autism	Drew 2007[137]			Poor+				Poor+			
Vineland Adaptive Behavior Scales	Harris 1995[168]										Poor+
	Paul 2004[169]							Fair+			
Vineland Adaptive Behavior Scales-Classroom version	Wells 2009[170]						Fair–				
Vineland Adaptive Behavior Scales-Screener version	Charman 2004[112]										Poor+
Autism Screening Instrument for Educational Planning (ASIEP and ASIEP 2)	N/A										
Child Behavior Scale	N/A										
Pragmatics Profile	N/A										
Social Communication Behaviour Codes	N/A										

N/A, not available.
Dark green, excellent; pale green, good; dark blue, fair; pale blue, poor.
–, negative; +, positive.

Social functioning (attachment, interaction skills with other children, awareness of others' emotions)

Measurement tool	Report ID	Reliability: Internal consistency	Reliability: Test–retest	Reliability: Inter-rater	Content validity	Structural validity	Hypothesis testing: Convergent/divergent	Hypothesis testing: Known groups	Criterion validity	Responsiveness: Stability	Responsiveness: Change
Autism Diagnostic Interview-Revised	Chawarska 2007[70]								Fair–		
	De Bildt 2013[139]	Good+									
	Frazier 2008[67]			Fair+		Good–					
	Kamp-Becker 2009[72]					Poor–					
	Lecavalier 2006[64]	Good+				Good–	Good–				
	Lord 1994[63]	Poor+		Poor+	Excellent+			Good+			
	Lord 2006[65]			Fair+							Fair+
	Moss 2008[71]			Poor+							Fair+
	Snow 2009[68]	Fair+				Fair–					
	Tadevosyan-Leyfer 2003[66]				Good+	Poor–	Good–				
	Tsuchiya 2013[69]			Good+				Good+			
	Ward-King 2010[140]		Poor+								
Nisonger Child Behavior Rating Form	Lecavalier 2004[199]	Fair+				Fair+					
	Lecavalier 2006[146]		Fair–	Fair–			Fair–				
Vineland Adaptive Behavior Scales	Harris 1995[168]										Poor+
	Paul 2004[169]							Fair+			
	Tyminski 2008[200]			Fair–							
Vineland Adaptive Behavior Scales-Classroom version	Wells 2009[170]							Fair+			
Vineland Adaptive Behavior Scales-Screener version	Charman 2004[112]										Poor+
Social Behaviour Rating Scale	N/A										

N/A, not available.
Dark green, excellent; pale green, good; dark blue, fair; pale blue, poor.
–, negative; +, positive.

Play (levels of play: exploratory to symbolic, organises own time/activities)											
			Reliability				Hypothesis testing			Responsiveness	
Measurement tool	Report ID	Internal consistency	Test–retest	Inter-rater	Content validity	Structural validity	Convergent/divergent	Known groups	Criterion validity	Stability	Change
Test of Pretend Play	Clift 1998[203]						Good+	Good+			
Developmental Play Assessment	N/A										
Structured Play Assessment	N/A										
Symbolic Play Test	N/A										

N/A, not available.
Pale green, good.
+, positive.

Behaviour (maladaptive behaviour, tantrums/meltdowns, aggression, self-injury)

		Reliability					Hypothesis testing			Responsiveness	
Measurement tool	Report ID	Internal consistency	Test–retest	Inter-rater	Content validity	Structural validity	Convergent/divergent	Known groups	Criterion validity	Stability	Change
Aberrant Behavior Checklist	Brinkley 2007[207]					Excellent+					
	Karabekiroglu 2009[205]	Fair+						Fair+	Fair+		
	Sigafoos 1997[206]			Fair–		Poor+					
Baby and Infant Screen for Children with aUtIsm Traits-Part 3 (BISCUIT-Part 3)	Matson 2009[83]	Good+									
	Matson 2009[208]	Excellent+				Excellent–					
Behavior Assessment System for Children-Parent Rating Scales, Second Edition	Hass 2010[182]	Fair+						Fair+			
	Mahan 2011[183]							Good–			
Child Behavior Checklist 1.5–5	Pandolfi 2009[185]	Good+				Good+					
Child Behavior Checklist 6–18	Pandolfi 2012[186]	Good+				Good+			Good+		
Home Situations Questionnaire-Pervasive Developmental Disorders version	Chowdhury 2010[212]	Excellent+				Excellent+		Excellent+			Excellent+
	Arnold 2012[210]										Good+
Nisonger Child Behavior Rating Form	Lecavalier 2004[199]	Good+				Good–					
	Lecavalier 2006[146]		Fair+	Fair–				Fair+			
Behavior Screening Questionnaire	N/A										
Child Behavior Scale	N/A										
Conners Rating Scales-Revised	N/A										
Developmental Behaviour Checklist	N/A										
Parent Target Problems or Parent Target Behaviours	N/A										
Preschool Behaviour Checklist	N/A										

N/A, not available.
Dark green, excellent; pale green, good; dark blue, fair; pale blue, poor.
–, negative; +, positive.

Habit problems [sleep latency and waking, (including actigraphy), eating problems, toileting problems]											
			Reliability				Hypothesis testing			Responsiveness	
Measurement tool	Report ID	Internal consistency	Test–retest	Inter-rater	Content validity	Structural validity	Convergent/divergent	Known groups	Criterion validity	Stability	Change
Child Behavior Checklist 1.5–5	Pandolfi 2009[185]	Good+				Good+/–					
Child Behavior Checklist 6–18	Pandolfi 2012[186]	Good+				Good+			Good+		
Sense and Self-Regulation Checklist	Silva 2012[153]	Good+	Fair+					Fair+			

Pale green, good; dark blue, fair.
–, negative; +, positive.

Learning (school readiness, early literacy, early numeracy)											
			Reliability				Hypothesis testing			Responsiveness	
Measurement tool	Report ID	Internal consistency	Test–retest	Inter-rater	Content validity	Structural validity	Convergent/divergent	Known groups	Criterion validity	Stability	Change
Autism Screening Instrument for Educational Planning (ASIEP and ASIEP 2)	N/A										
Extended Basic Academic Skills Assessment System	N/A										
Wechsler Individualised Achievement Test	N/A										

N/A, not available.

Daily living skills (feeding self-using cutlery, dressing self)											
			Reliability				Hypothesis testing			Responsiveness	
Measurement tool	Report ID	Internal consistency	Test–retest	Inter-rater	Content validity	Structural validity	Convergent/divergent	Known groups	Criterion validity	Stability	Change
Vineland Adaptive Behavior Scales	Harris 1995[168]										Poor+
	Paul 2004[169]							Fair–			
Vineland Adaptive Behavior Scales-Classroom version	Wells 2009[170]						Fair+				
Vineland Adaptive Behavior Scales-Screener version	Charman 2004[112]										Good+
Functional Independence Measure for children	N/A										

N/A, not available.
Pale green, good; dark blue, fair; pale blue, poor.
–, negative; +, positive.

Global measure of function											
			Reliability				Hypothesis testing			Responsiveness	
Measurement tool	Report ID	Internal consistency	Test–retest	Inter-rater	Content validity	Structural validity	Convergent/divergent	Known groups	Criterion validity	Stability	Change
Assessment, Evaluation, and Programming System	Wang 2011[213]	Poor+									Poor+
Behavior Assessment System for Children-Parent Rating Scales, Second Edition	Hass 2010[182]	Poor+									
	Mahan 2011[183]							Good+			
Psychoeducational Profile-Revised	Alwinesh 2012[215]	Poor+	Good+	Poor+			Excellent+				
	Heimann 2006[219]							Poor+			Poor+
	Shek 2005[216]	Poor+	Fair+	Fair+					Fair+		
	Steerneman 1997[217]	Poor+					Fair+	Fair+			
	Villa 2010[218]	Poor+		Fair+					Good+		
Psychoeducational Profile-Third Edition	Chen 2011[222]										Poor–
	Fu 2010[221]	Fair+		Fair+							
Psychoeducational Profile-Third Edition, Caregiver Report	Fu 2012[223]	Poor–		Fair–					Poor–		
Scales of Independent Behavior-Revised	Brown 2010[225]						Poor–				
	Lecavalier 2006[146]	Fair+						Fair+			
Vineland Adaptive Behavior Scales	Harris 1995[168]										Poor?
	Paul 2004[169]							Fair+			
	Tyminski 2008[200]		Fair–								

Global measure of function

Measurement tool	Report ID	Internal consistency	Reliability: Test–retest	Reliability: Inter-rater	Content validity	Structural validity	Hypothesis testing: Convergent/divergent	Hypothesis testing: Known groups	Criterion validity	Responsiveness: Stability	Responsiveness: Change
Vineland Adaptive Behavior Scales-Classroom version	Wells 2009[170]							Fair+			
Vineland Adaptive Behavior Scales-Screener version	Charman 2004[112]										Poor+
Ages and Stages Questionnaire	N/A										
Assessment of Basic Language and Learning Skills	N/A										
Brigance Diagnostic Inventory of Early Development	N/A										
Developmental Profile	N/A										
Early Development Interview	N/A										
Early Intervention Developmental Profile	N/A										
Early Learning Accomplishment Profile	N/A										
Functional Emotional Developmental Questionnaire	N/A										
Learning Accomplishment Profile-Diagnostic, Third Edition	N/A										
Paediatric Daily Occupation Scale	N/A										
Preschool Developmental Profile	N/A										

N/A, not available.
Dark green, excellent; pale green, good; dark blue, fair; pale blue, poor.
?, indeteminate; –, negative; +, positive.

Global measure of outcome											
			Reliability				Hypothesis testing			Responsiveness	
Measurement tool	Report ID	Internal consistency	Test–retest	Inter-rater	Content validity	Structural validity	Convergent/divergent	Known groups	Criterion validity	Stability	Change
Autism Treatment and Evaluation Checklist	Charman 2004[112]										Poor–
	Geier 2013[121]								Good+		
	Magiati 2011[309]	Poor+					Poor+				Poor+
Behavioral Summarized Evaluation	Barthelemy 1990[86]			Fair+	Excellent–	Poor–					
	Oneal 2006[88]	Poor+				Poor–	Fair+				
Revised Behavioral Summarized Evaluation Scale	Barthelemy 1997[87]			Poor+		Fair–	Fair+		Poor–		
	Roux 1995[89]					Excellent+					
PDD Behavior Inventory	Cohen 2003[123]	Good+		Good–	Excellent+	Good+					
	Cohen 2003[123]								Fair–		
Infant Behavioral Summarized Evaluation	Adrien 1992[90]			Fair+		Poor+					
Clinical Global Impression – Improvement Scale	N/A										

N/A, not available.
Dark green, excellent; pale green, good; dark blue, fair; pale blue, poor.
–, negative; +, positive.

Social inclusion (social participation, social exclusion, difficulty with attending appointments, awareness of danger)

Measurement tool	Report ID	Internal consistency	Reliability		Content validity	Structural validity	Hypothesis testing		Criterion validity	Responsiveness	
			Test–retest	Inter-rater			Convergent/ divergent	Known groups		Stability	Change
School Liking and Avoidance Questionnaire	N/A										
Teacher Rating Scale of School Adjustment	N/A										

N/A, not available.

Interaction style (synchrony, shared attention)

Measurement tool	Report ID	Internal consistency	Reliability		Content validity	Structural validity	Hypothesis testing		Criterion validity	Responsiveness	
			Test–retest	Inter-rater			Convergent/ divergent	Known groups		Stability	Change
Functional Emotional Assessment Scale	N/A										
NICHD Early Child Care Network scales	N/A										

N/A, not available.

Parent stress (parent stress, parent coping style, parent anxiety and depression)											
			Reliability				Hypothesis testing			Responsiveness	
Measurement tool	Report ID	Internal consistency	Test–retest	Inter-rater	Content validity	Structural validity	Convergent/divergent	Known groups	Criterion validity	Stability	Change
Autism Parenting Stress Index	Silva 2012[153]	Excellent+	Poor+			Poor?		Good+			
Parenting Stress Index-Short Form	Lecavalier 2006[146]	Fair+					Fair+			Fair+	
	Zaidman-Zait 2010[229]	Poor+				Poor?					
	Zaidman-Zait 2011[230]	Excellent+				Excellent+	Poor–				
Questionnaire on Resources and Stress	Honey 2005[232]	Fair+				Poor?	Fair+				
Beck Anxiety Inventory	N/A										
Center for Epidemiologic Studies Depression Inventory	N/A										
General Health Questionnaire	N/A										
Hospital Anxiety and Depression Scale	N/A										
Parenting Sense of Competence	N/A										
Positive and Negative Affect Scale	N/A										
Reaction to Diagnosis Interview	N/A										
Satisfaction with Life Scale	N/A										
Stress Arousal Checklist	N/A										
Symptom Checklist-90-Revised	N/A										

N/A, not available.
Dark green, excellent; pale green, good; dark blue, fair; pale blue, poor.
?, indeteminate; –, negative; +, positive.

Family quality of life (impact on family, family cohesion)											
			Reliability				Hypothesis testing			Responsiveness	
Measurement tool	Report ID	Internal consistency	Test–retest	Inter-rater	Content validity	Structural validity	Convergent/divergent	Known groups	Criterion validity	Stability	Change
Beach Family Quality of Life Questionnaire	N/A										
Family Adaptability and Cohesion Evaluation Scales	N/A										
Family Assessment Device-General Functioning Scale	N/A										
Family Assessment Measure	N/A										
Family Empowerment Scale	N/A										
Family Support Scale	N/A										
Kansas Inventory of Parental Perceptions	N/A										
McMaster Family Assessment Device	N/A										
Parenting Alliance Inventory	N/A										

N/A, not available.

Appendix 9 List of new tools encountered

'New' tools meet the criteria for stage 3 (i.e. included in a paper about measurement properties with children with ASD) but were not found in stage 2 (i.e. not yet used as outcome measurement tools with ASD children up to 6 years old in observational or intervention evaluation studies).

Name of new tool

Autism Spectrum Disorder Observation for Children (ASD-OC).

Autism Spectrum Disorder-Diagnostic for Children (ASD-DC).

Autism Spectrum Disorders-Comorbidity for Children (ASD-CC).

Behavioral Assessment of Social Interactions in Young Children (BASYC).

Behaviour Function Inventory (BFI).

Bender Visual-Motor Gestalt Test-Second Edition (BG-II).

Brief Autism Mealtime Behavior Inventory (BAMBI).

Caregiver Strain Questionnaire (CGSQ).

Carey Temperament Scales.

Children's Global Assessment Scale – Developmental Disabilities Modification (DD-CGAS).

Children's Communication Checklist (CCC).

Children's Scale of Hostility and Aggression: Reactive/Proactive (C-SHARP).

Children's Sleep Habits Questionnaire (CSHQ).

Children's Social Behavior Questionnaire (CSBQ).

Children's Yale-Brown Obsessive Compulsive Scales (CYBOCS).

Child's Challenging Behaviour Scale (CCBS).

Classroom Observation Schedule to Measure Intentional Communication (COSMIC).

Developmental, diagnostic and dimensional interview (3Di) – shortened form.

Family Inventory of Sleep Habits.

Happe's Strange Stories.

Health Utilities Index (HUI) 3.

Manchester Inventory for Playground Observation (MIPO).

Modified Simonds & Parraga Sleep Questionnaire (MSPSQ).

Modified-Classroom Observation Schedule to Measure Intentional Communication (M-COSMIC).

Motivation Assessment Scale (MAS).

Multi-dimensional Scale for Pervasive Developmental Disorder and attention-deficit/hyperactivity disorder (MSPA).

Parent Interview for Autism-Clinical Version (PIA-CV).

Perceptions of Children's Theory of Mind Measure (Experimental version; PCToMM-E).

Quality of Well-Being Self-Administered (QWB-SA) scale.

Repetitive and Restricted Behaviour Scale (RRB Scale).

Repetitive Behaviour Questionnaire (RBQ).

Responsive Augmentative and Alternative Communication Style (RAACS) scale Version 2.

Sensory Experiences Questionnaire.

Social and Communication Disorders Checklist (SCDC).

Social Cognitive Evaluation Battery (SCEB).

Social Orienting Continuum and Response Scale (SOC-RS).

Social Vulnerability Scale (SVS).

Social-Communication Assessment Tool (S-CAT).

Standardized Observational Analogue Procedure (SOAP).

Test of Pragmatic Language (TOPL).

Theory of Mind Inventory (ToMI).

Theory-of-Mind (ToM) Storybooks.

Wing Subgroups Questionnaire.

Yale–Brown Obsessive–Compulsive Scale (Y-BOCS).

EME
HS&DR
HTA
PGfAR
PHR

Part of the NIHR Journals Library
www.journalslibrary.nihr.ac.uk

This report presents independent research funded by the National Institute for Health Research (NIHR). The views expressed are those of the author(s) and not necessarily those of the NHS, the NIHR or the Department of Health

Published by the NIHR Journals Library